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THE EDDYSTONE LIGHTHOUSE.

OF all the dangerous rocks by which the coasts of Great Britain are begirt, the Eddystone Reef, a few miles off Plymouth, is one of the most formidable. It is a long jagged ridge, stretching for hundreds of yards across the track of channel-going vessels. The first beacon house built upon this rock was constructed by Henry Winstanley, an eccentric self-taught mechanician. It was a polygonal column of about 100 feet in height, adorned with carving, gilding, and painting, but it was deficient in the most necessary requirement, strength, for in the great storm of 1703 it was swept completely away, and its builder, who, having been informed that rough weather was approaching, had determined to spend the night with the keepers, like them lost his life. The next lighthouse, mainly constructed of oak, was commenced in 1706 by John Rudyerd, a London silk mercer, was completed in 1709, and after braving the fury of the elements for nearly half a century, was destroyed by a fire, which originated in the lantern. The three light-keepers were rescued by fishermen from the coast, but to two of the three the disaster proved fatal, one being driven mad by fright, and dying in that condition, and another, an old man of ninety-four, succumbing to the effects of the molten lead which ran down his throat while he was trying to extinguish the flames. His story was disbelieved, but he died in great agony, and half a pound of lead was found in his stomach. The third lighthouse, which is still standing, was erected by John Smeaton, also a self taught man, though an engineer by profession. It was commenced in 1756, and finished in 1759, and has thus for six score years fulfilled its mission of warning to the mariner. It is built of stone, each piece being dovetailed into its fellows, and into the rock beneath, and it is as strong now as ever; but its stability is endangered by the inroads which have been made by the sea upon the natural rock on which it stands, and the Corporation of the Trinity House have, therefore, begun the construction of a new one to supply its place. Our illustration shows the relative position of the old and new lighthouses, and also some of the difficulties of the work. A twin-screw steamer, the Hercules, fitted with every sort of ingenious contrivance, is employed for putting the stones ashore, and pumping out the water from the work on the rock. Her crew have worked together for a long time, and the order and smartness with which everything is done is wonderful. An irregular circle of brickwork has been built as a shelter, and inside this the rock is quarried out and grooved to receive the stones, all of which are dovetailed, and fit into each other like the pieces of a puzzle. In the center of all is a core of masonry supporting the crane used for lowering the heavy stones into their places.

The whole is covered with water except at low tide, and even then if the sea is at all rough it breaks over the rock with great force, as is shown in our sketch, which was taken on the 20th of June, when Mr. Douglas, of the Trinity House, the designer of the new lighthouse, accompanied by his son and Mr. Edmond, the engineer in charge of the works, landed to make all secure before the rising gale. Nothing is trusted to subordinates, and the management of the boats in broken water was perfection itself. Were it not so the task would be by no means a safe one.

On the 21st of June the Prince of Wales and the Duke of Edinburgh went to Plymouth with the intention of laying the foundation of the new lighthouse, but the weather was too rough to allow of anything of the kind being done. Their Royal Highnesses, however, visited the works at Oreston, where the stones are cut and fitted prior to being taken out to the reef, and the Duke of Edinburgh not only promised to perform the ceremony at some later day, probably in August, but also that the Duchess should lay the top stone when the building is completed.—*London Graphic.*

FOUNDATION OF THE NEW EDDYSTONE LIGHT, WITH VIEW OF THE OLD LIGHTHOUSE.

PROF. ROOD divides the spectrum of white ligh tinto 12 parts, and multiplies the space occupied by each part by the relative luminous intensity. In that way he obtains the following numbers: Red, 54; orange red, 140; pure orange, 80; orange yellow, 114; yellow, 54; greenish yellow, 206; yellowish green, 121; green and greenish blue, 134; prussian blue, 32; blue, 40; violet approaching to ultramarine, 20; pure violet, 5. The quantity of light in the "warm" colors is thus three times greater than that in the "cold" colors.

MINOT'S LEDGE LIGHTHOUSE.

By J. G. BARNARD, U. S. A.*

THE lighthouse on Minot's Ledge is the most important engineering work that belongs to our lighthouse system; and indeed it ranks, by the engineering difficulties surmounted in its erection, and by the skill and science shown in the details of its construction, among the chief of the great *sea-rock* lighthouses of the world.

"Minot's Rocks—or, as they are generally designated, 'the Minots'—lie off the southeastern *chop* of Boston Bay. . . . These rocks or ledges, with others in their immediate vicinity, are also known as the 'Cohasset Rocks,' and have been the terror of mariners for a long period of years; they have been, probably, the cause of a greater number of wrecks than any other reefs or ledges upon the coast, lying as they do at the very entrance to the second city of the United States in point of tonnage, and consequently where vessels are continually passing and repassing. The Minots are bare only at three-quarters ebb, and vessels bound in with the wind heavy at northeast, are liable, if they fail to the leeward of Boston Light, to be driven upon the reefs. The rock selected for the site of the lighthouse is called the 'Outer Minot,' and is the most seaward of the group. At extreme low water an area of about 30 feet in diameter is exposed, and the highest point in the rock is about 8½ feet above the line of low water. It is very rare, however, that a surface greater than 25 feet in diameter is left bare by the sea. The rock is granite, with vertical seams of trap rising through it."

This work is one of peculiar engineering interest. The site had been occupied by an iron skeleton lighthouse, built (1848) by Captain W. H. Swift, of the United States Topographical Engineers, and carried away by the great storm of 14th, 15th, 16th, 17th of April, 1851. The history of this work, and of the catastrophe which befell it, is briefly given in the article "Lighthouse Construction," in Johnson's Cyclopedia.

The structure of which the model was exhibited succeeded the work just alluded to.

* Transactions of the American Society of Civil Engineers.

The difficulties of the work will be best appreciated from the following statement of the engineer.*

"It was a more difficult work of construction than either the Eddystone, the Bell Rock, or the Skerryvore, for the Eddystone was founded all above low water, part of its foundation being up to high-water level. The foundation of the Bell Rock was about 3 feet above low water, while the Skerryvore had its foundation above high-water level; whereas a good part of the foundation of the Minot's light was below low water. There had to be a combination of favorable circumstances to enable us to land on the Minot Rock at the beginning of that work—*a perfectly smooth sea, a dead calm, and low spring tides.* This only could happen about six times during any one lunation—three at full moon and three at the change. Frequently, one or the other of the necessary conditions would fail, and there were at times months, even in summer, when we could not land there at all. Our working season was from April 1 to September 15."

Both an elevation and a vertical section are given herewith. The shaft is purely conical, the limited bottom area forbidding the expansion required for the tree-like spread to the base—which is usual in European sea-rock lighthouses.

The structure is solid (around a central well) up to the level of the entrance door. Above that there is a hollow cylindrical space, 14 feet in diameter, arched over at the level of the cornice. This space is divided into five stories by four iron floors. These five compartments, and a sixth, immediately under the lantern, constitute the keeper's rooms, store-rooms, etc. There is here shown an elevation and vertical section of the tower, and also horizontal sections showing the "bond" of the stonework of the solid parts, also of the Eddystone, Bell Rock, Skerryvore, and

Number tons of rough stone	3,514
Number tons of hammered stone	2,367
Number stones in lighthouse	1,079

The first stone was laid July 9, 1857; the lowest stone was laid July 11, 1858:

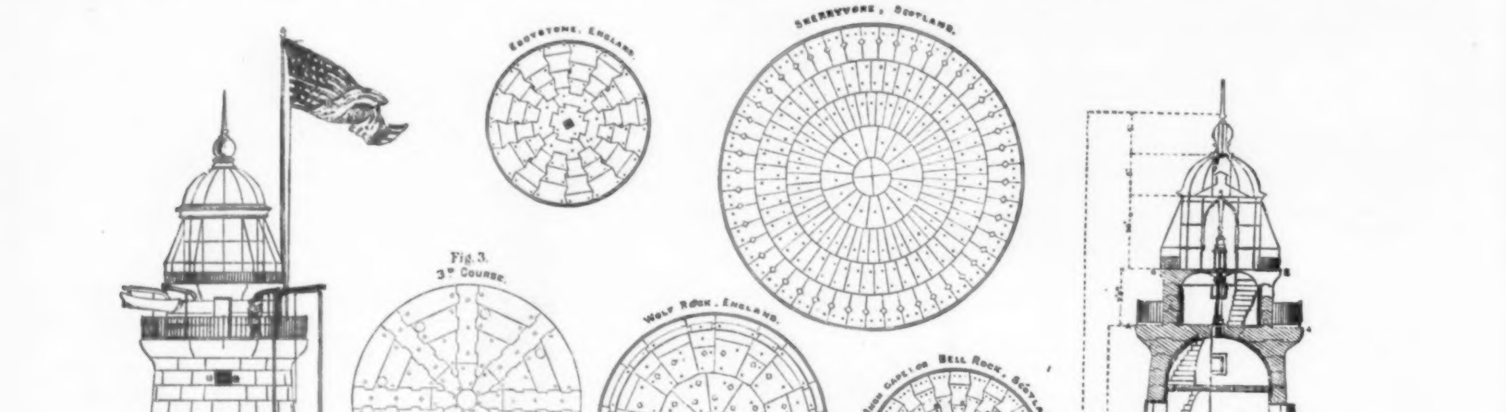
Whole height from bottom of lowest stone to top of pinnacle	114' 1"
Height of focal plane above lowest point	96' 1"
" " " mean high water	84' 7"
Diameter of third (or first full) course	30'
" top of twenty-second course (solid part)	23' 6"

Observations made at Boston Lighthouse from June 7 to October 27, 1847, furnish the following results:

Rise of highest tide	14 ft. 7 in.
Mean rise and fall of tides	9 " 4 "
" " " spring tides	10 " 8 "
" " " neap "	8 " 3 "

Besides the Minot's but one other specimen of that kind of lighthouse construction is offered by the Lighthouse Establishment of the United States. That one (Spectacle Reef), of which the model of the caisson and coffer dam used in building the foundation, and of the finished structure, were exhibited. This is not properly a "sea rock" lighthouse, nor are the destructive agencies it has to encounter sea-waves, but chiefly ice packs.

It stands upon a reef in the northern part of Lake Huron, off the eastern end of the Straits of Mackinac. It is built upon the southern extremity of the most northerly of two shoals (limestone rock *in situ*, covered with a layer of about two feet in thickness of bowlders), so situated with reference to each other as to suggest the name, "Spectacle Reef."



MINOT'S LEDGE LIGHT HOUSE

WITH COMPARATIVE SECTIONS OF OTHER

SEA ROCK LIGHT HOUSES

Wolf Rock towers. There is, besides, a plan of the Rock itself as prepared to receive the foundation stones, in which the numbers (with the plus or minus sign) indicate the level of the respective areas—*e. g.* (—1' 3") indicate 1 foot 3 inches below the zero; which zero, however, is itself 1' 9" above mean low water. The small black disks mark the holes for the iron shafts of the old structure. In these, continuous dowels were inserted, which ascended as far as the twelfth masonry course. In the horizontal section the gun-metal dowels are marked, by which each course of the solid part was secured to the one above or beneath. The courses of the shell above the solid part were each joggled by a middle annulus with the course above. The following details are given for reference.

The first blow was struck on the ledge Sunday morning at sunrise, July 1, 1855:

Hours worked on ledge in excavating foundation pit during 1855	130 hours.
Hours worked on ledge in excavating foundation pit during 1856	157 hours.
Hours worked on ledge in excavating or laying four stones during 1857	130 h. 21 m.
Hours worked on ledge in excavating pit and in laying six courses during 1858	208 hours.
Hours worked on ledge in laying twenty-six courses of stone during 1859	377 hours.
	1,102 h. 21 m.

* In a succeeding number of the "Transactions" will be found the only connected "memoir" left by the engineer, the late Lieutenant-Colonel B. S. Alexander (Brevet Brigadier-General, U. S. A.), on the history of the construction of this work.

The least depth of water on the shoal is about 7 feet, but at the site selected for the lighthouse the rock was found at a depth of 11 feet. The nearest land is the southeasterly point of Bois Blanc Island, distant 10½ miles. The greatest exposure to waves is to the southeastward, from which direction the seas have a range of about 170 miles. Were there no other destructive agency, sufficient stability would have been easily secured. But, under certain meteorological conditions, currents having a velocity of from 2 to 3 miles per hour are developed here, which during the inclement season serve to move to and fro ice fields which frequently have an area of thousands of acres and a thickness of as much as two feet. This ice, formed in fresh water, is of great solidity, and when moving in the mass, and with the velocity named, has a "living force" which is almost irresistible. The aim was to oppose to it a structure against which the impinging ice would be crushed and packed till it should ground upon the shoal itself, and form a barrier against subsequent action. To give some idea of the necessity for this, it may be mentioned that in the spring of 1875 the ice was piled up against the lighthouse to the height of 30 feet above the water, or 7 feet above the sill of the doorway, which is 23 feet above the lake, and when the keepers went to the station to exhibit the light (not in operation during the winter) they were able to obtain entrance to the tower only by first cutting a passage through the pile of ice referred to.

One of Heslop's winding and pumping engines, a patent for which was granted in 1790, has been presented by the Earl of Lonsdale to the Patent Office Museum, South Kensington.

GAS ENGINES.

At a congress in Brussels, in 1877, of the chief engineers of the French and Belgian associations for inspecting steam boilers, it was the opinion of the meeting that steam engines are not the motors for small industries. The reasons given for this opinion were that small boilers are difficult to examine, their repairs are very costly, and their life is comparatively short. It was agreed that the small motor of the future is to be found in electric, hot air, compressed air, hydraulic, or gas engines. The last mentioned was justly regarded as that which has met with the greatest success.

It is only natural that the stringent laws which regulate the application and working of steam boilers on the Continent, should have the effect of increasing the demand for any practicable form of motor that does not come under harsh government inspection with its severe tests and penalties, but we were scarcely prepared to find boiler engineers going, we might almost say, out of their way to advocate the use of gas engines, as it is obviously against their interest, in some measure at least, to do so.

Notwithstanding the favorable opinion of gas engines entertained by steam-boiler engineers on the Continent, there still exists a very strong prejudice against gas engines among engineers in general on this side of the Channel. This prejudice arose from the failure of the first gas engines introduced from France some time ago. These engines were wrong in principle. It was overlooked by their inventors that the sudden but unsustained pressure consequent upon the explosion of a strong mixture of coal gas and air exerted against a piston was not so suitable as the sustained pressure of steam for obtaining a steady motion of a crank and flywheel. To this oversight, as well as to a considerable amount of complication, necessity for skilled attendance, trouble from heating, and expense of working, the failure of these first gas engines was mainly due. There are still about a score of these engines working in this country, but most of those set to work have been abandoned or converted into steam engines, a change which their construction readily admitted.

The defect in principle has been entirely removed in the gas engines of the present day, of which we have given a description from time to time as they made their appearance.

Nearly all the drawbacks attendant upon the use of steam, especially for small powers, are due to the risk, attention, and anxiety inseparably connected with the use of the boiler, and it must have occurred to many steam users what a blessing it would be if the steam engines could be used without a boiler. Now, it is just this desideratum that a good gas engine is designed to meet, and the success which has attended the introduction of at least one type of gas engine, renders it easy to predict with certainty that a large new field will be opened out for the employment of motive power; that many small industries will be greatly developed and extended and new industries created, now that a cheap motive power can be employed without the risk and trouble of having a steam boiler on the premises. For instance, the advantage of being able to start a gas engine at full power by lighting a jet and turning the flywheel, instead of having to wait till steam is raised, renders it of great value as a fire engine in country mansions and other isolated buildings, where it can also be used daily for pumping, lifting, laundry work, and ventilating. The gas engine appears to offer to architects a way out of the difficulty they have hitherto found

in efficiently ventilating buildings for want of a suitable motor. In crowded rooms fresh air can be drawn in from the most suitable side of the building, according to the season, time of day, and locality, by means of a fan, and distributed and diffused where required without producing dangerous or unpleasant local draughts, which are only too often felt with the present primitive, not to say barbarous, modes of ventilation still in vogue. The little attention given to proper ventilation in costly buildings, and the want of success hitherto in overcoming the mechanical difficulties in the way, are not very creditable to our architects and engineers.

The destruction by fire of several buildings recently has been ascribed to the presence of a steam boiler on the premises. The danger from fire by storing or removing the hot ashes is greatly increased when the boiler is placed on any story above the ground floor. So great is this danger that the insurance rates are often so high as to preclude the use of steam boilers by the tenants in the higher floors of a build-

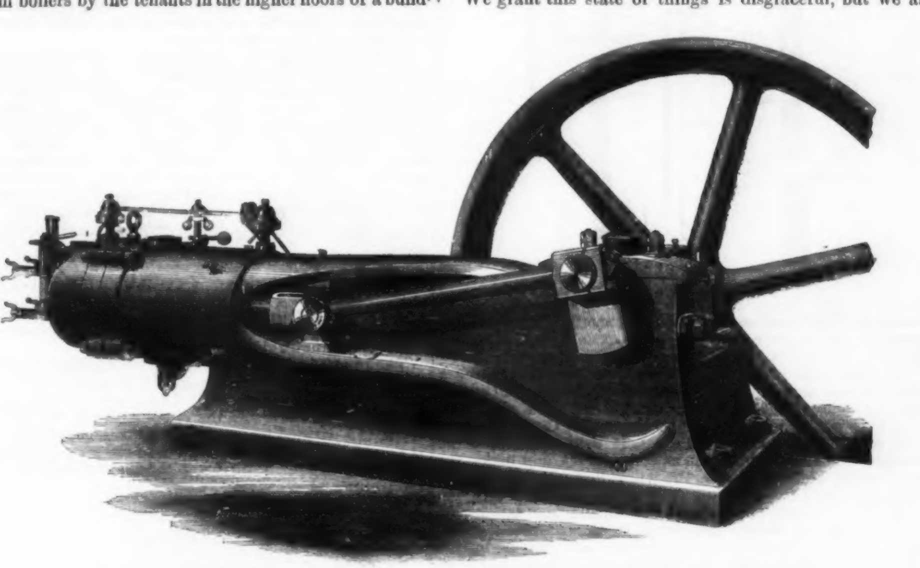


FIG. 1.—SIXTEEN-HORSE OTTO SILENT GAS ENGINE.

ing, and often leads to the exclusion of steam power altogether on the part of the owner. This prohibition of the use of steam power has proved to be a great tax on many small industries, and in the working of cranes and hoists in warehouses in London and other places where the cost of working hydraulic engines direct from the main is too great to admit of their use. The want of a suitable motor to work in the upper floors no longer exists, as gas engines, working up to twelve horse power, can be applied without any more risk or trouble than accompanies the use of a steam engine without a boiler.

With respect to the comparative economy of working small steam engines and gas engines, this depends chiefly upon the relative prices of steam and of coal gas. Taking the price of coal per ton, and that of gas per one thousand cubic feet in some towns in the north where cannel gas is used, the relative prices are two to one, while in London they are as five to one, so that if the cost of working were the same for gas and steam in Manchester, the cost of working in London would be over 50 per cent. in favor of the gas engine, a slightly smaller quantity by volume of gas being required for a given amount of work when rich cannel gas is used.

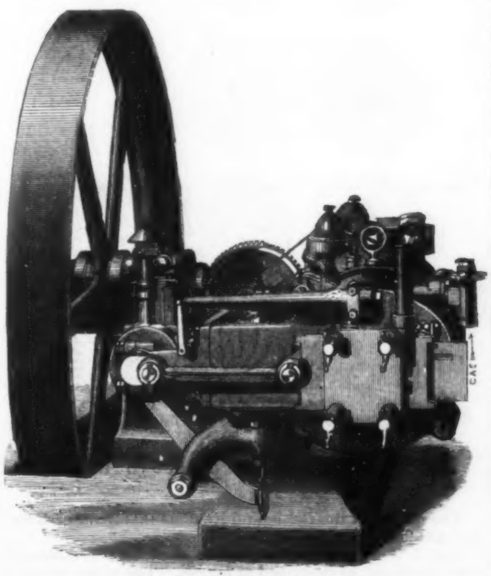


FIG. 2.—SIXTEEN-HORSE "OTTO" GAS ENGINE.

The Otto gas engine is said to require not more than 23 ft. of gas per indicated horse power per hour. At London prices this is equivalent to about one penny per hour. A steam engine, working at the same cost with coal at 18s. per ton, would take 13½ lb. per horse power per hour. This appears at first sight a very extravagant rate of consumption even for a small steam engine, say under eight horse power. But as the superior economy of the gas engine has been repeatedly proved where it has worked side by side with a steam engine, it may be as well to inquire into the cause of the extravagant cost of working in many small steam engines. These are used for many purposes where the resistance is very irregular, the power required varying, perhaps, from one to eight horse power. In a very great number of small steam engines and boilers over, say, four or five years old, the amount of steam lost by leakage at joints, taps, glands, slide valves, and piston rings, forms a large proportion of the quantity of steam generated, and the further great quantity of heat lost through the chimney, and by radiation from the furnace, boiler, and pipes, bears a not inconsiderable proportion of that utilized. As this waste is a pretty constant quantity, whether the engine is giving off one or eight horse power, it follows that the amount of fuel used is not at all proportionate to the power developed. When the engine is indicating two horse power, almost as much fuel may be used as when it is indicating six horse. With a leaky safety valve and steam stop valve it sometimes requires a considerable quantity of coal to raise steam and keep it up a few hours at the working pressure even with the engine at rest.

We grant this state of things is disgraceful, but we are speaking of things as we have too often found them, and not as they ought to be. There is little hope for improvement in this matter with many small steam users. As long as they have a boiler which furnishes them with a means of making up for the waste of steam and heat by wasting more coal, they prefer doing so to being at the expense of having their boiler fittings and engines put into good order. There are thousands of small boilers and engines at work, upon each of which the judicious outlay of a few shillings annually in necessary repairs would yield a return of as many pounds.

In the case of a steam engine and boiler in fair order, and doing intermittent work, there is always a considerable loss in getting up or maintaining steam. With the best forms of gas engines the case is very different. When the engine is in fair order, the quantity of gas used is always in proportion to the power exerted. A certain volume of gas is drawn from the meter just when it is required. Should the engine not be in good order, and there be an escape of the expanding gases past the piston rings, there will be a waste and loss of power, and more gas will be required, but this loss soon reaches its limit. An engine, say of the Otto type, cannot use more gas than the quantity corresponding to its maximum power. Such an engine, working up to within 25 per cent. of its greatest power, cannot waste more than 25 per cent. of the greatest amount of gas it is designed to use. When the piston rings require renewal, the defect is

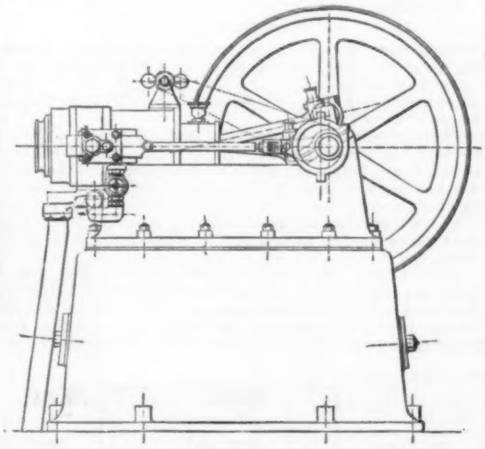


FIG. 3.—CLERK'S GAS ENGINE.

made manifest by the escape of the burnt gases, and in order to regain the power which the engine loses in consequence, the rings must be renewed, and so economy is mercifully forced upon the user. In a steam engine, on the other hand, the waste of steam in escaping past the piston is easily made up by burning more coal, and this waste is only limited by the quantity of air that can be made to pass through the fire bars. The above consideration will serve to show why it is that in practice gas engines are often found to work at one-third the cost of small steam engines they have replaced.

Besides the economy in fuel there is also a great saving in attendance where a gas engine is used, as there is no stoking and maintenance of pressure and water level requiring special attention. When oiled and started the engine can be locked up and left to itself for hours like a steam engine. The handiness of the gas engine was strikingly illustrated in the Royal Albert Hall, at the recent exhibition of electrical light apparatus. In the course of the lecture, the engine in the body of the hall upon a given signal was started from a state of rest, the belt slipped on to the pulley and the light produced, all in a few seconds. The engine might be left for a week or more and the same thing repeated without any preparation.

Gas engines may be often used with great advantage as auxiliaries to large steam engines. In many works a steam engine of over 50 horse power is run all night to drive a long line of shafting in order to work a small machine requiring not more than a couple of horse power. The loss in coal, attendance, and wear and tear is often very great when this work is often repeated. By using small steam engines the evil is only partially remedied, as the fireman has to be in attendance. To meet such cases gas engines have been applied, with great advantage, as the man who attends to the machine can start the engine and give the little attention it requires, and the cost of working is reduced to a minimum.

It is, however, in connection with small industries that gas engines will most likely be employed in the future. Where steam is required for heating, boiling, and other purposes, the steam boiler will always hold its ground, but for many minor industries we may say that the days of small steam boilers are numbered.

LATEST IMPROVED GAS ENGINES.

Gas engines form an important section of the exhibits at Kilburn (Royal Agricultural Show), and are largely represented, the most extensive exhibitors being Messrs. Crossley Brothers, of Manchester, who show a number of different sizes of their well known "Otto" engines, all of which will be exhibited at work. We give views of the largest of these engines, this being called 16 horse power. The engine has a cylinder 13 in. in diameter, and 18 in. stroke, and is, therefore, we believe, the largest and most powerful single-cylinder gas engine which has yet been constructed. Its speed is 160 revolutions per minute, at which it indicates 32 to 33 horse power. In principle this engine does not differ from other "Silent Otto" engines, one of which we described and illustrated some time since.

Its framing is very massive, and is self-contained, so that no outer pedestal is necessary, both bearings being in one bedplate, and the flywheel overhung. The lay shaft from which the valves are worked runs along at the back of the cylinder—as seen in the end view—being driven by a bevel pinion placed just inside the further bearing. The air and gas distribution slide is placed, as formerly, at the back of the cylinder, and is worked by a small crank on the end of the lay shaft. The principle of its action is, as will be remembered, that during one forward stroke it permits the admission of air and gas in proper proportions, in the corresponding back stroke allows this to be compressed, in the next forward stroke ignites the mixture, which expands, driving the piston before it, and is finally pushed out in the next back stroke. The governor acts on the engine by permitting the admission of gas only every third, fourth, etc., stroke, instead of every second stroke as when the engine is at full work.

The cylinder is made with a separate liner, between which and the outer shell (cast on the frame) is a water jacket for keeping the cylinder cool. The whole is built to stand a working load of 12 tons on the piston, which has involved very great stiffness and substantiality in all the different parts in proportion to the size of the cylinder.

This type of "Otto" engine continues to be really exceedingly successful, if figures prove anything, for we hear that over 2,000 of them have been made since their introduction, less than two years and a half ago, and nearly half of the whole number have been constructed by Messrs. Crossley. One of them, at the Hinckley Gas Works, has come successfully through the most severe trial of running night and day for over fourteen months without any expenditure for repairs—a result that certainly speaks well for the extent of the surfaces provided by Messrs. Crossley, as well as for the general excellence of their work. The engine illustrated used (on trial in Manchester) under 21 cubic feet of gas per indicated horse power per hour; its cost for fuel would, therefore, be only about three farthings per indicated horse power per hour, a result—we need scarcely say—extremely satisfactory. The engine, in fact, has not yet been displaced from the position which it at once took for itself, of being, to all appearance, far the best gas engine at present before the public. There are, however, several competitors now in the market, from which much is expected by their respective makers, and we can only hope that these engines may be fairly tested, and on trial fully satisfy their expectations.

Messrs. Thomson & Sterne exhibit a 2-horse gas engine of a new type, the invention of Mr. Dugald Clerk, of which they have taken up the manufacture. In this machine, of which we give an engraving, two cylinders of the same size are used, one as a driving cylinder and the other as a compressing pump, and the two are connected by a small reservoir. The mixture of air and gas is compressed in the pump (instead of in the cylinder itself as in the Otto engine), and then passed through the reservoir into the cylinder, where it is ignited. The cylinder is double-acting, and by this arrangement two ignitions per revolution are obtained instead of one in two revolutions. The most ingenious feature about this engine is, however, probably its igniting arrangement. A little cage of platinum wire is used for this purpose, which, having once been heated to redness, remains always hot, for each time it causes an explosion to take place it receives from the hot gases as much heat as is necessary to make up for its loss of heat otherwise. This plan appears both simple and certain in its action, a very important thing, especially in this particular matter in a gas engine. We are told that as many as 400 ignitions have been made in a minute by this apparatus, while the intended speed of the engine shown is 200 revolutions per minute.—*Engineering.*

THE CHANNEL TUNNEL.

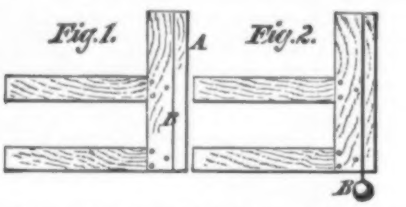
IT appears that the boring that is making at Sangatte, in France, is not the beginning of the shaft from which the tunnel is to be bored, but is merely an experimental borehole, some five or six hundred yards above the village and about one hundred yards from the shore, so that it is small wonder that for three months the work has been suspended, because of the too rapid infiltration of water, while a new pump of double the capacity of the present one is building, that is, one which can raise about six hundred and seventy-five gallons a minute. The shaft for the tunnel when it is begun is to be sunk in the village itself, and will be sunk to such a depth as the experiments now making shall show to be necessary. The experimental shaft, which is at present only one hundred and twenty-three feet deep, is to be sunk to a depth of two hundred and sixty feet, the diameter of the bore being eleven feet

HOW TO ADJUST LINE SHAFTING.

By Joshua Rose.

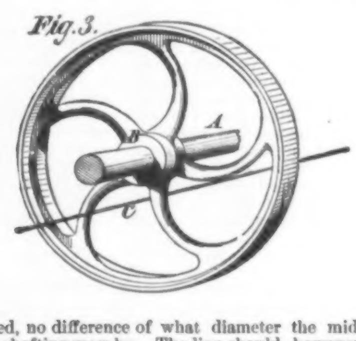
A correspondent asks us for some accurate method of lining shafting, and says that for want of knowledge upon the subject, his shafting runs out of true; and as results, the belts have an unequal tension upon them, the bearing boxes get heated, and the couplings get loose, giving him constant trouble. As we have from time to time received a number of similar communications, we give the following information upon the matter.

There are several methods of lining line shafting, and some of them are found to be decidedly defective in practice. One of the most common of these is that of hanging plumb lines over the shaft, and then stretching a line, parallel with the line shaft, but near the floor, and then adjusting the line shaft until the plumb lines are all equidistant from, or have precise and equal contact with, the stretched line, thus accomplishing the horizontal adjustment. This is a crude and troublesome operation for several reasons, among which may be mentioned the fact that it is difficult to measure between such lines when they are long, and that as the line shaft is moved during adjustment, the plumb lines sway about, involving the necessity of some one to steady them. They are furthermore in the way; and the contact by swaying of a single one with the stretched line interferes with the whole operation. For the vertical adjustment a spirit level alone



is sometimes employed; and this is objectionable for the reasons, among others, that there is nothing to guide the operator as to whether the part he begins at, and which we will suppose requires to be adjusted, should be lifted at the one end or lowered at the other, in order to make an adjustment suitable to the general line of the shafts. He may, it is true, first test the whole line of shaft, and make a note of the result arrived at at each testing place, using the notes as a guide to the readiest method of adjustment. It is better, however, in every respect, to adopt the plan here recommended, which is as follows: First prepare a number of rude wooden frames, such as are shown in Fig. 1. They are called targets, and are pieces of wood nailed together, with the outer edge face, A, planed true, and having a line marked parallel with the planed edge and about ¾ inch inside of it.

This is intended for use as a guide, in conjunction with the plumb line shown in Fig. 2, attached at B. The next proceeding is to stretch a line parallel with, but vertically below the line of shafting, sufficiently to clear the largest hub upon any of the pulleys on the line of shafting, as shown in Fig. 3, in which A represents the shafting, B the largest pulley hub, and C the stretched line. In adjusting this line, we have, however, the following considerations: If the whole line of shafting is parallel in diameter, we set the line equidistant from the shafting at each end. If one end of the shafting is of larger diameter, we set the line further from the surface of the shafting, at the small end, to an amount equal to one half of the difference in the two diameters; and since the line is sufficiently far from the shafting to clear the largest hub thereon, it makes, so far as stretching the line is

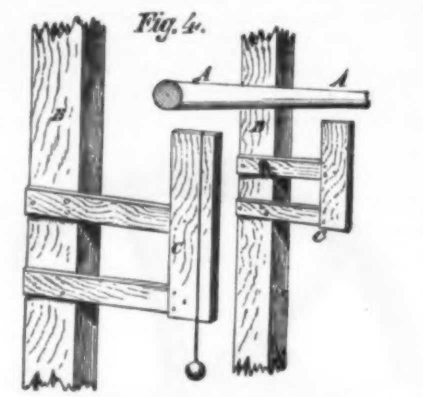


concerned, no difference of what diameter the middle sections of shafting may be. The line should, however, be set true as indicated by a spirit level.

We may now proceed to erect the targets as follows: The planed edge, A, in Fig. 1, is brought true with the stretched line, and is adjusted so that the plumb line, B, in Fig. 2, will stand true with the line or mark, B, in Fig. 1. When so adjusted, the target is nailed to the post carrying the shafting hanger. In performing this nailing, two nails may be slightly inserted so as to sustain the target, and the adjustment being made by tapping the target with the hammer, the nails may be driven home, the operator taking care that driving the nails does not alter the adjustment. In Fig. 4, A A represents the line of shafting, B B two of the hanger posts, and C C two of the adjusted targets.

Having adjusted and fixed in the manner above described a target to each of these posts supporting a shafting hanger, we may remove the horizontal stretched line, and take a wooden straight edge long enough to reach from one post to another. Then beginning at one end of the shafting, we place the flat side of the straight edge against the planed edge of two targets at a distance of about 15 inches below the top of shafting; and after leveling the straight edge with a spirit level, we mark (even with the edge of the straight edge) a line on the planed edge of each target; and we then move the straight edge to the next pair of targets, and place edge even with the mark already made on the second target.

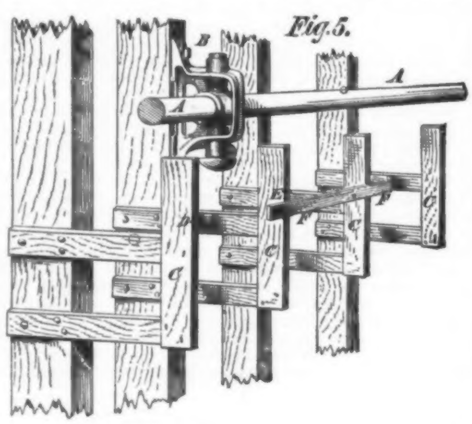
We then level the straight edge with a spirit level, and mark a line on the third target, continuing until we have marked a straight and horizontally level line across all the targets, the operation being shown in Fig. 5, in which A A represents the line of shafting B B the hangers, and C C the targets. D represents the line on the first target, and E the line on second. F is the straight edge, leveled ready to form a guide whereby the line, D, or target, may be carried forward, level and straight, to target 3, and so on across all the targets. The line thus marked is the standard whereby the shafting is to be adjusted vertically; and for the purpose of this adjustment, we must take a piece of wood or a square such as is shown in Fig. 6, the edges, A B, being true and at a right angle to each other. The line D, in Fig. 5, marked across the targets being 15 inches below the center line of the shaft at the end from which it was started, we make a mark upon our piece of wood, the line C, in Fig. 6, 15 inches from the edge, A (as denoted by the dotted line in Fig. 6); and it is evident that we have only to adjust our shaft for vertical



height so that, the gauge (shown in Fig. 6) being applied as shown in Fig. 7, the shaft will be set exactly true, when the mark, C, on the piece of wood comes exactly fair with the lines, D, marked on the targets.

For horizontal adjustment, all we have to do is to place a straight edge along the planed face of the target, and adjust the shaft equidistant from the straight edge as shown in Fig. 8, in which A is the shaft, B the target, C the straight edge referred to, and D a gauge. If then, we apply the straight edge and wood gauge at every target, and make the above described adjustment, the whole line of shafting will be set level and true.

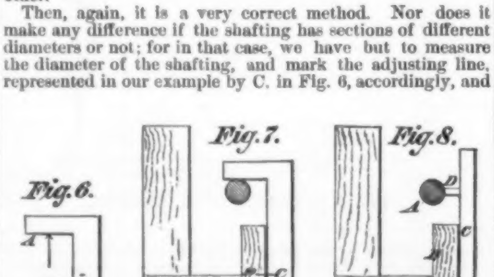
There are several points, however, during the latter part of the process at which consideration is required. Thus, after the horizontal line, marked on the targets by the straight edge and used for the vertical adjustment, has been struck on all the targets, the distance from the center of the shafting to that line should be measured at each end of the shafting; and if it is found to be equal, we may proceed with the adjustment; but if, on the other hand, it is not found to be equal, we must determine whether it will be well to lift one end of the shaft and lower the other, or make the whole adjustment at one end by lifting or lowering it as the case may be. In coming to this determination we must bear



in mind what effect it will have on the various belts, in making them too long or too short; and when a decision is reached, we must mark the line, C, in Fig. 6, on the gauge accordingly, and not at the distance represented in our example by the 15 inches.

The method of adjustment thus pursued possesses the advantage that it shows how much the whole line of shafting is out of true before any adjustment is made, and that without entailing any great trouble in ascertaining it; so that, in making the adjustment, the operator acts intelligently and does not commence at one end utterly ignorant of where the adjustment is going to lead him to when he arrives at the other.

Then, again, it is a very correct method. Nor does it make any difference if the shafting has sections of different diameters or not; for in that case, we have but to measure the diameter of the shafting, and mark the adjusting line, represented in our example by C, in Fig. 6, accordingly, and



when the adjustment is completed, the center line of the whole length of the line of shafting will be true and level.

This is not necessarily the case if the diameter of the shafting varies, and a spirit level is used, directly upon the shafting itself. In further explanation, however, it may be well to illustrate the method of applying the gauge shown in Fig. 6, and the straight edge, C, and gauge, D, shown in Fig. 8, in cases where there are in the same line sections of shafting of different diameters. Suppose, then, that the line of shafting in our example has a mid section of 2¼ inches diameter, and is 2 inches at one, and 2½ inches in diameter at the other end. All we have to do is mark on the gauge, shown in Fig. 6, two extra lines, denoted in Fig. 6 by D and E. If the line, C, was at the proper distance from A for the section of 2¼ inches diameter, then the line, D, will be at the proper distance for the section of 2 inches, and E at the proper distance for the section of 2½ inches diameter: the distance between C and D, and also between C and E, being ⅛ inch, in other words, half the amount of the difference in diameters. In like manner for the horizontal adjustment, the gauge piece shown at D, in Fig. 8 would require, when measuring the 2¼ inches section, to be ⅛ inch shorter than for the 2 inches section, while for the 2½ inches section would require to be ⅛ inch shorter than that used for the 2¼ inches section, the difference again being one half the amount of the variation in the respective diameters. Thus the whole process is simple, easy of accomplishment, and very accurate.

If the line of shafting is suspended from the posts of a ceiling instead of from uprights, the method of procedure is the same, the forms of the targets being varied to suit the conditions. The process only requires that the faced edges of the targets shall all stand plumb and true with the stretched line. It will be noted that the plumb lines (shown on the target in Fig. 2, at B) are provided simply as guides whereby to set the targets, and are put at about ¾ inch inside of the planed edge so as to be out of the way of the stretched line. It is of no consequence how long the stretched line is since its sag does not in any manner disturb the correct adjustment.

MILLSTONE DRESS AND DRESSING TOOLS.*

Millstone Dress.—(Grinding.)—*a.* The arrangement and disposition of the furrows in the face of a millstone.

b. The draught given to the furrows.

The object of the various kinds of dressing is to secure the proper proportional quantity of material on the stone from the eye to the skirt. The kinds of dress are known as the quarter dress and the circular dress. In the former the face is divided up into a number of sectors, each of which is known as a quarter, and has its own set of furrows. The advance edge of a furrow is the leading edge, the other is the trailing edge.

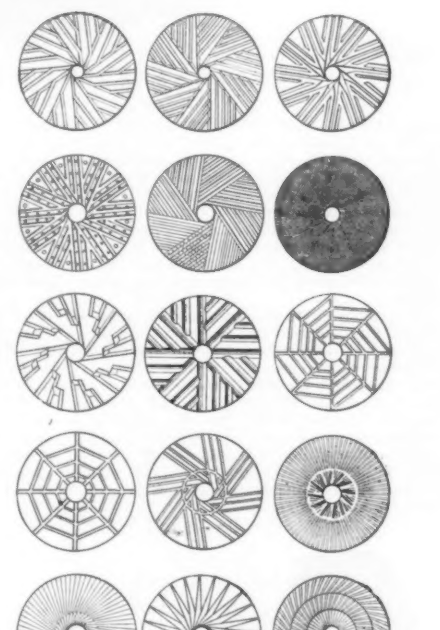


Fig. 1.—MILLSTONE-DRESS (BUHRS).

The querns of the Celtic and Roman inhabitants of Britain had notches, forming a dress.

Fig. 1 is a collection of views of different millstones, which will not be described at length. The upper examples are quarter dress; then follow specimens of radial and circular dress, then a number of curved and circular systems.

In addition to the features involving direction are others, such as openings in the bed or runner, forming pockets, or for ventilation, or to allow escape of fine flour. Natcher's patent of 1858 is for ruling lines with a diamond on the land of the stone to give it a cutting quality.

In corn and feed mills, with serrated iron plates for grinding, the dress is different, as shown in Fig. 2. Many of these plates are frustums of cones or conoids.

Millstone Dresser.—A machine for cutting grooves in the grinding face of a millstone.

In one form of the machine the lines radiating from the center are made by a tool raised and dropped by a cam and

* From Knight's "Mechanical Dictionary," published by Messrs. Hurd & Houghton, New York city.

advancing automatically along a radial arm attached to a central axis.

A Swiss machine for dressing millstones is shown in Fig. 4. The frame, A, has arms, *b b*, terminating in feet, *c'*, which are provided with set screws. A tool support, S, is pivoted to the center of A, and is adjustable by means of sector, B, and slides on the arm, C, of the frame. Two disks at K carry diamonds or other hard stones on their peripheries,

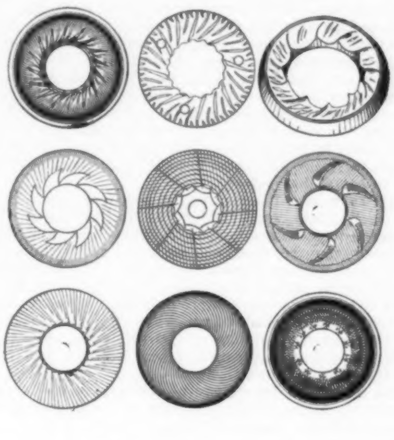


FIG. 2.—MILLSTONE-DRESS (IRON PLATES).

and are set in rapid revolution by belts from spindle, J, which is revolved from any convenient shaft outside the millstone.

The cutting disks being put in rapid revolution, the successive blows of the diamonds act in a manner similar to that of a hand tool, and parallel grooves are cut in the face of the stone. Three of these sets of parallel channels or grooves make one division of the stone. The guide bar, C,

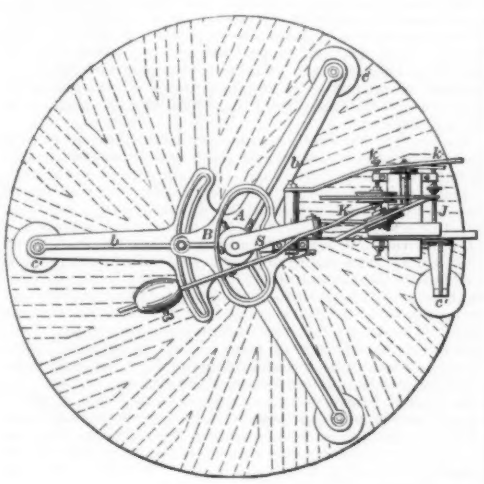


FIG. 3.—MILLSTONE-DRESSER.

is adjustable, so that the stone may have a right-hand or left-hand dress, as desired.

In the machine shown in Fig. 4, a number of pick plates of tempered steel, H, are held in a hollow block, D D, which latter slides vertically in a holder, E E. A cap fitting over the pick plates and secured to the hollow block, G, is struck by a mallet when dressing, while the holder is pushed along

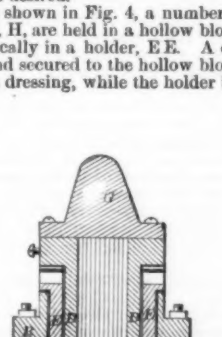


FIG. 4.—MILLSTONE-DRESSER.

on the guide. Standards, C C, with screw heads, permit the vertical adjustment of the holder when the points of the pick plates become worn. A A is the bed, which rests on the millstone when the machine is in use.

Millstone Grit—A refractory sandstone of which the sides and hearth of a blast furnace are composed.

Millstone Hammer.—A tool for furrowing millstones. A millstone pick. In the example shown the blades have a

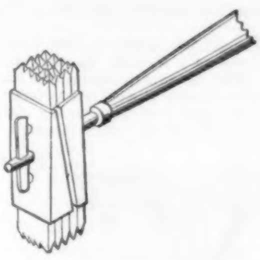


FIG. 5.—MILLSTONE-HAMMER.

central hole for the reception of the handle, and are inclosed by a box whose sections have a diagonal junction.

Millstone Pick.—A tool for dressing millstones. The hard steel blade is held in a stock, and may be set forward as it wears away, a lip on the heel of the blade setting in one

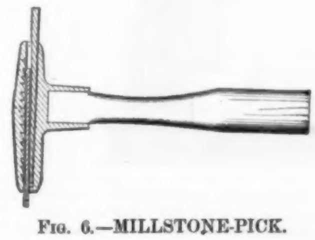


FIG. 6.—MILLSTONE-PICK.

or another of the notches in the stock. A wedge holds the blade in any position.

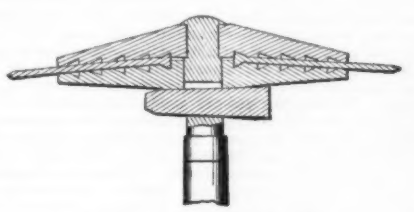


FIG. 7.—MILLSTONE-PICK.

In Fig. 7 the blades have conical heads, and are held by wedging the portions of the stock together.

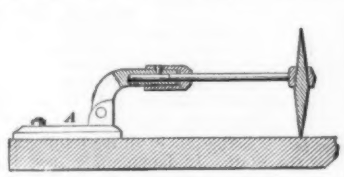


FIG. 8.—MILLSTONE-PICK.

Fig. 8 is hinged to a bed plate, A, which slides over the stone while the pick is vibrated.

SCIENTIFIC NOTES.

BY the help of three hundred pounds of dynamite the Vanguard has been relieved of her masts, and the ill fated ironclad has at length been abandoned, even by the wreck ship Petrel, which has until lately watched over her grave.

There are, however, those sangine enough to believe that we have not seen the last of the Vanguard, and that there remain untried means by which she and similar unlucky craft can be raised from their ocean bed. Among the various suggested plans by which this could be accomplished, perhaps the most promising is that of Mr. Thomas A. Dillon, who had lately the honor of showing his experiments and explaining his system to H. R. H. the Duke of Edinburgh.

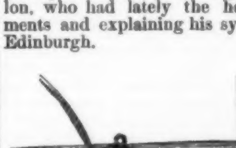


FIG. 2.

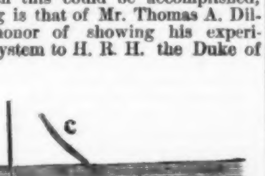


FIG. 1.

Mr. Dillon has kindly favored us with a repetition of these experiments, a brief summary of which we now place before our readers.

Like many other successful inventors, Mr. Dillon employs apparatus of the most simple description, and, with a sponge bath to represent the Atlantic Ocean, and a tin canister, pierced with holes, to personate a sunken ship, he demonstrates his process of recovering a wreck.

His first experiment is represented in Fig. 1. A is an inverted glass vessel which, to a certain extent, plays the part of a diving bell. B is the tin canister, and C an India rubber pipe communicating outside the tank with a foot blower. The glass bell is held firmly down by hand, as the air is pumped into it. The water by this means is rapidly driven out from the glass, and also from the tin canister. When this is wholly accomplished the bell is lifted up, and the canister comes up with it—a recovered wreck.

In another experiment (Fig. 2), a small model boat is used for the wreck, which corresponds, on a small scale, in relation to the height of the water above it, with the actual measurements obtained from the scene of the Vanguard disaster. The glass bell is in this experiment replaced by a kind of skeleton dish cover, having within it a loose lining of calico. Upon the air being pumped into this contrivance, the same effect is produced as in the first experiment, the vessel is relieved of water and jumps to the surface. The capability of wet calico to hold compressed air—although it must be familiar to every washerwoman—has not before been put to such practical use; and as our readers will remark, it forms a most noticeable feature in Mr. Dillon's experiments.

We will now look to the method in which it is proposed to carry out these ideas upon a large and practical scale (see Fig. 3.) A represents a wreck, and B B two ships which are anchored above it. C represents the end of a number of steel ropes which are stretched from keel to keel of the ships,

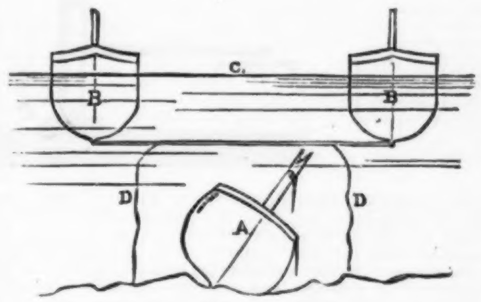


FIG. 3.

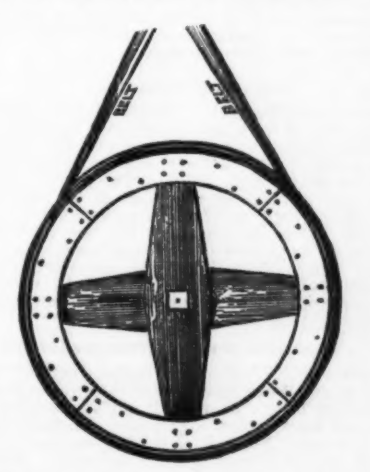
B B. A bell of canvas is shown in section at D D, its bottom edge being weighted with chain. Let us now suppose that air is pumped into the canvas bell from the ships B B, and that it is prevented from rising to the surface by the steel ropes, C, which form a network above it. At the proper moment these ropes are released, when the canvas bell rises to the surface—with the wrecked ship beneath it. When this is accomplished a valve is opened in the upper part of the bell, the water thereupon rushes in below and urges the lower canvas curtain D D against the sides of the leaky vessel, effectually preventing its return to the bottom. Such briefly is Mr. Dillon's plan for recovering lost ships. That experiments in a sponge bath must differ materially from the experience likely to be met with when battling with the wind and tide on the open sea every one will admit, but the results, so far as they go, are so hopeful, and the end sought so important, that further trials on a large scale are contemplated. With this view both the Admiralty authorities and the Thames Conservancy have given Mr. Dillon facilities for carrying out further experiments.—*London Graphic*

A HOME MADE HORSE POWER.

By WILLIAM ROBT. BROOKS.

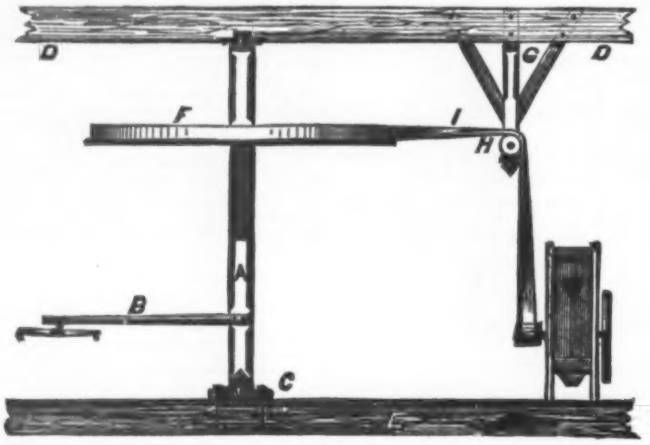
THE convenience and value of a simple horse power on the farm are felt by the average farmer far oftener than the convenience itself is enjoyed. With the majority of men the item of first cost is the great obstacle to the possession of such a device. Herewith I present an illustration of what I am confident will be found a valuable home made power, the cost of which will be but a trifling drawback to its possession.

The sketches show its construction very clearly, and the short description will enable any farmer to erect a good and serviceable machine. One day's work by an intelligent carpenter would, however, be of assistance to some. It consists of a square upright shaft, A, which may be eight feet high and six inches square, of any well seasoned wood. Bolted to this shaft is a sweep, B, to which the horse is to be attached. A light, round pole should also be fastened to the upright shaft projecting in front of the horse, to lead him round in his circular walk. In the top and bottom of the shaft, A, are iron journals $1\frac{1}{4}$ or $1\frac{1}{2}$ inch diameter, taken from some old mowing machine, for instance, or they may be obtained at the village blacksmith's. These are driven firmly into the shaft, and they turn with it in bearings overhead, and in the step, C, below. The whole arrangement is supposed to be erected in the barn or shed; D representing a beam, and E the floor. Fastened to the upright shaft is a wooden pulley, F, at least six feet above the floor and seven or more feet in



diameter. The thickness of this wheel should be four or five inches, with a flange on the bottom one inch thick.

The wheel may be constructed by nailing together segments of plank, the arms also being built as the segments are nailed together. Depending from the beam, D, is a strongly braced frame, G, carrying two loose pulleys, H (one only is shown), over which the belt, I, passes thence downward to the pulley on the machine to be driven. In this case a corn sheller is represented. The loose pulleys should be on a level with the center of the driving wheel, and just outside the circle described by the sweep, B. It will be seen that gearing is entirely dispensed with, and the motion will be smooth and noiseless. Should a higher motion be wanted than could be got by attaching directly to the machine, an auxilary shaft or "jack" could be easily interposed. For shelling corn, cutting feed, cleaning grain, pumping water, sawing wood, churning, and numerous other duties, this simple device will be found an invaluable addition to the farm conveniences.—*Rural New Yorker.*



LOWELL.—STATISTICS OF WAGES AND LIVING.

The first of the great cotton mills of Lowell commenced operations in 1823. Now the entire capital stock in the several corporations is nearly $17,000,000.

Whole number of spindles	800,000
" " looms	19,000
Females employed	12,000
Males "	8,000
Yards made per week—cotton	3,500,000
" " woolen	115,000
" " carpeting	40,000
Pounds cotton consumed per week	1,000,000
Pounds clear wool consumed per week	175,000
Yards of cotton cloth dyed and printed per annum	93,000,000

The statistics from a single mill would suffice to show not only the magnitude of the enterprise, but the enormous capital needed, and the intelligence and forethought required to successfully direct its business in all the numerous details.

WHAT IMPROVED MACHINERY HAS DONE.

As a result of the very great changes in machinery since 1860, the work in the factory is not only done better, but at a less waste of material, and the cost of production in labor reduced 25 per cent. Labor is also less arduous. To such perfection has machinery been brought, that from 60 to 64 per cent. less labor is now required for a given amount of product, than in 1860. The machinery is also run at nearly double the speed, a single operative now turning out in a given time about one-third more work than it was possible to do in 1860. Three-fourths of all the labor in the mills to-day is done by women, and every year the work is more and more coming into their hands.

Until recently the greater part of the machinery used was imported, as it was believed that it could not be made so well at home as in England, but home built machinery, for all purposes, is now preferred. It not only does its work better, but is better adapted to our operatives and to the American system of management.

The process of

MULE SPINNING

in most of our mills needs reforming. It is the most tedious and laborious of work, and though mule spinners generally receive the highest wages, they are the most discontented and exacting of the mill hands and are generally the promoters of nearly all the strikes. The trouble is with the work more than with the workmen. It has been truly said that "the only way to reform the mule spinner is to abolish the mule." Already machinery for this work has been introduced; its perfection and general use is only a question of time. When this shall have been accomplished, this class of work also will come into the hands of women, and a great step will have been taken against future strikes.

If one judges of the

CONDITION OF OUR FACTORY OPERATIVES

by reports which often come to us from outside, he would expect to find in our New England cities a class of wretched, half-starved beings, prematurely old by overwork, discouraged and heart broken over present hardships and a still darker future. No such class of operatives is found in Lowell, else all outward signs are deceptive. Their homes are found neat and attractive, and somehow old and young manage to dress well. Their tables are supplied with good food, they have spare money for occasional excursions or to attend places of amusement, while many of the more industrious and frugal have respectable accounts in the savings banks; but after all, the most telling fact is the large attendance and creditable standing of their children in the public schools.

AVERAGE EARNINGS.

The following figures were taken from the books of one of the leading corporations of Lowell:

Average earnings of girls per week in 1860	$3 26
Board per week in 1860	1 25
Leaving net earnings per week in 1860	$2 01

Average earnings of girls per week in 1878	$4 34
Board per week in 1878	1 75
Leaving net earnings per week in 1878	$2 59

The facts, therefore, show that in 1860 female operatives, working eleven hours a day (66 hours a week), received $3.26, while in 1878 the female operatives, when working ten hours a day (60 hours a week), received $4.34. This applies only to one class of operatives, but the average given is found the same with all the other classes.

It is also true that the gold dollar of to-day will buy more food and clothing than the gold dollar of 1860. Turning to the market quotations of 1860, we find superfine flour $5.50 per barrel; the same quality is now quoted at $5. Mess pork is now quoted at $11 per barrel; in 1860 it was $18. Lard is now eight cents a pound, against 14 in 1860; corn is now 50 cents a bushel, against 70 in 1860; molasses is 35 cents a gallon, against 40 in 1860. Sugar and coffee are higher now than in 1860, but with very few exceptions the necessaries of life are lower now than ever before. In cotton goods, prints, and wearing apparel generally, the prices of to-day, compared with 1860, show a reduction even more marked.

The changes in the character of the operatives have been no less marked than in the improved machinery brought into use. In the first twenty years the operatives in the mills of Lowell were nearly all Americans, mostly sons and daughters of New England farmers—many coming from New York State—and all attracted by the better wages offered than could be had at home. To-day the operatives are mostly all foreigners, some English and French, but mainly Irish, while the strictly American element is very small. The figures below will show the rapid increase in the

FOREIGN POPULATION

of the city, which is attributable to this remarkable change in the factory operatives:

Year.	Population.	Foreign.
1836	17,633	2,661
1844	25,163	2,864
1855	37,553	8,500
1865	30,990	9,422
1875	49,688	17,788
1879	53,000	19,000

The same fact is noticeable in all the leading manufacturing cities of the State. In Lawrence 45 per cent. of the population are foreign born; in Holyoke, 52; and in Fall River, 53 per cent.

WHAT CHARLES DICKENS SAID OF LOWELL.

Charles Dickens visited Lowell in 1842, to examine critically the great factories, and contrast their management with similar works in his own country. He devoted an entire chapter in his "American Notes" to the mills. He, who was so quick in detecting faults and so ready to make them known, found nothing in the character and management of these great factories but what received his heartiest approval. "I have carefully abstained," he writes, "from drawing a comparison between these mills and those in my own country. The contrast would be a strong one, for it would be between the good and evil, the living light and deepest shadow." He was pleased at the careful arrangements for the health and comfort of the operatives, and seemed especially so with the appearance of the operatives themselves. "The girls," he states, "were all well dressed, ladylike in appearance, intelligent, and the picture of good health." He noted the fact that in the institution for savings there were $386,000 on deposit, $250,000 of this sum belonging to operatives in the mills. But there were three facts that surprised and delighted him. "There is a joint-stock piano in a great many of the boarding houses, nearly all the young ladies subscribe to circulating libraries, and they have got up among themselves a periodical called the *Lowell Offering*, which is duly printed, published and sold, and whereof I brought away from Lowell four hundred good solid pages, which I have read from beginning to end; and putting entirely out of sight the fact of the articles having been written by these girls after twelve or fourteen hours of hard labor, this publication will compare advantageously with a great many English annuals."

A STRIKING CONTRAST.

About the same time that Dickens wrote the above of the mills in Lowell, an Englishman, in an article in one of the English magazines, sketched the factory system in Leeds and Manchester. An extract will suffice to show the wide contrast: "The lower orders—for God's sake quarrel not with the word low, for they are all as low as tyranny can tread them down, and in many places as much parts of machinery as are the spindles themselves—are but cogs. The more delicate parts of machinery soonest wear out, and these are boys and girls. You can have no conviction of the waste of infants. The weak wretches are soon worn out and flung away. True, they are not expensive; they are to be purchased from their parents at low prices. The truth is, are too cheap. Their very bodies are worth more than they bring, and then there is one error in the calculation which, great as it seems to us, has been seldom noticed—seldom has buyer or seller thought of inserting their souls." Then follows a more minute picture of the factories in Manchester, giving the hours of labor, the character and condition of the operatives. There are no schools, nor anything that can lend an influence to lift this great mass of wretched humanity to a better condition; nothing is within their reach that offers the least encouragement. It was in an atmosphere like this that trades unions had their birth; but those who bring them to this country know nothing of the real character of our institutions. The

CONDITIONS ARE ALL DIFFERENT.

Here the public school is open to poor and rich alike. Manchester and Leeds have their resident operatives, a dependent factory caste—once in the factory, seldom or never a door is found open for escape. In the mills of Lowell the operatives are constantly changing. This has been so from the start, and from the nature of things must always continue. Manufacturing began here by drawing from the very best class of New England young men and girls, who remained until better chances offered elsewhere, others taking their places, and like them used the mills only as stepping stones to something better.

Surely there is nothing in the employment itself that debases, as the fifty years' history of the best mills of New England proves. It is a fact, that however low and sluggish new comers may be, close contact with active, hopeful life inspires in them new hope and new life. Those who are in the mills to-day are not expected to remain a single day after they have found a pursuit more profitable or better suited to their tastes. Our country is a wide one; all nationalities are welcomed, with choice of pursuit open alike to every individual, each taking the place he is best fitted to fill. And while there are millions of acres of land, good enough for the best, and cheap enough to be within the easy range of the poorest, none should grumble of their hard work or poor pay.—*Boston Journal of Commerce.*

SUPREMACY IN MANUFACTURES THE HERITAGE OF AMERICA.

The third of a series of letters from Manchester, England, relating to English and American manufactures, lately printed by the New York *Tribune*, contains so clever a statement of the advantages of America as the leading manufacturer in the world that it is worthy of the widest reading. The writer says:

A reasonable faith in the progressive development of manufactures in the United States leads me to believe that in the near future the scepter of England, as the controlling factor in manufactures, will soon pass over to America. The reasons that compel and justify this conviction are, briefly and in part only, as follows:

An operative cannot work for less wages than will support himself and family. It costs nearly twice as much to live in England as it does to live equally well in the United States. And, after all, cheap food is the chief factor in the problem of cheap labor. Given (1) machinery of equal perfection; (2) operatives of equal skill; and (3) unequal terms as to the cost of food—cheap food will turn the scale in its favor always.

I take it, in the first place, that so far as the cost of food is concerned there can be and there is no question, in fact, about your ability to produce it at lower cost than it can be furnished in England. This being admitted, the second question of the relative perfection of machinery s one about which there can be room for little controversy, inasmuch as all agree that the inventive genius of Americans is of the first order. The useful and labor-saving inventions which have made your countrymen justly famous among civilized nations everywhere attest that if the past can be safely taken as a promise of the future, they have no reason to fear that they will lag in the race wherein genius employs latent forces to do the work of man. In all branches of manufactures common to the two countries there is little difference in the kinds of perfection of machinery in use. And where there is any variation, I am sure, as a rule, it will be found that your inventions are best adapted for your needs. The time has passed when any new invention can long continue a monopoly in a small circle, for the fierce light of competition pierces the inmost recesses of factories and brings into general use the latest improvements.

As to the relative skill of operatives, it may be safely asserted that those who are best capable of judging agree in the estimate that Americans are at least the equals of English operatives. This, then, is sufficient for the present inquiry. If I am right in my reasoning, it follows that cheap food is really the pivot on which the control of manufactures is to hinge. The cost of labor must always be governed, in large measure, by the cost of living. Especially is this true in periods of dull trade, when profits are small and competition is keen. It is in these times that the manufacturers cut down wages, and labor must earn enough to support life, or operative and manufacturer must go to the wall.

Substantial wealth cheapens money. The more there is of it, the easier it is to get. This is too clear to need more than a mere statement of a well-known fact. In the United States wealth is increasing in a marvelous ratio. I need not occupy space in recurring to statistics to elaborate a truth universally admitted. The varied sources of income, reaching into a thousand centers of activity, are pouring out their returns in a vast volume, which, year by year, enormously swells the grand total of your national wealth. Formerly, and until recently, from seven to ten per cent was considered only a fair rate of interest on sound and long-time investments.

This, in large part, since 1860, was the result of an inflated currency. It was a burden of the war, in its way. Specie payments will insure lower rates of interest. The war period led to extravagances in countless ways, and the tide of speculation rose high in all your borders. The temptation of winning riches at a venture lured multitudes to ruin, by causing them to stake their all and lose it in the lottery of uncertain and delusive schemes. This period has passed in the main, and the long travail of business depression from which you are just emerging has taught you pretty effectually the hard lessons of industry, economy, and sound financial operations. The first great benefit is that of cheaper money. I am confident that five years hence—assuming that a healthy growth will be maintained—the rate of interest in the United States will be at least one per cent. lower than it is to-day. This will strengthen your manufacturers, and in the almost vital element of cheap money will place them on a par with English capitalists. This is a point of commanding importance, for low rates of interest in England long enabled manufacturers to furnish cheaper goods than you could, owing to your high rates of interest.

Your vast area furnishes a variety in climate and lands for the million—two essentials—comparatively impossible in England. Experience teaches that cycles of depression re-

cur at quite regular intervals in all countries. In these periods overstocked labor must find employment in tilling the soil. Your own history has taught you that this is a relief approaching almost to a cure in the most trying times of dull trade. In manufacturing centers, where population increases rapidly, this "sea-room"—to use a nautical phrase—is a place where operatives out of work can find a safe refuge, and at the same time relieve manufacturers as well as themselves. To-day the great need in England is cheap lands, to which suffering operatives might be easily transferred at small cost, so as to enable them to raise from the soil what charity now has in many cases to bestow—food to eat and clothes to wear.

The question of cheap raw materials is, perhaps, not less nor more important than the points that have preceded it. Each is, in a sense, the complement of the others. Nature has lavishly bestowed her varied treasures on your continent. Gold, silver, wood, coal, copper, iron, and almost endless natural productions are found in abundance in easy reach of the artisan, while the soil yields a variety and profusion of crops for the use and comforts of man. Nowhere in the world are the natural advantages so favorable for the cheap production of raw materials in most of the chief manufactures of the age as they are in the United States. Considered in connection with the theory that manufactures can be produced cheapest near the point where the raw materials are found, this last question is indeed important.

My purpose in these three letters has been merely to point out in brief some of the reasons that convince me that England's long supremacy in manufactures is at an end. Her extremity is your opportunity. It is your right to take up the lead in the line of march of this peaceful rivalry if you can. For one, I firmly believe that the day is not far distant when American manufactures will undersell all others in near and distant markets. Let it not be thought that I do not fully appreciate the wealth and power of England. I know her marvelous energy, her vast possibilities, and her indomitable pluck. But space cannot be overcome, and the inventive powers of other nations have wrought changes that no human agency can reverse.

THE PREPARATION OF COTTONSEED-OIL.

THE seeds of the cotton-fruit, after being separated from the cotton in the so-called "gin," are packed in sacks, and in this shape sold to manufacturers of the oil. The latter empty the sacks on floors, where the seeds are frequently turned over with shovels to prevent their heating. The first process which the seeds then undergo is a preliminary cleaning in drums lined with a fine metallic net, and containing a strong magnet to which any iron nails will adhere which are frequently present. From the drums the seeds drop into a gutter leading to a machine which removes the still adhering remnants of cotton. The clean seeds are then transferred to the shellers, in which the exterior shell is removed from the kernel; the mixed shells and kernels are separated in a winnowing machine by a strong blast of air. Being thus cleaned, shelled, and separated, the kernels are ground to flour between two smooth cylinders, 29·5 inches long and 8 inches in diameter, revolving 40 or 50 times a minute, and capable of grinding about 264 kilogrammes (580 lb.) of kernels per day.

Cold pressure of the kernels produces a very good salad oil; but in this country warm pressing is generally preferred. The ground seeds are first heated in steam cylinders for 15 to 20 minutes to 96–102° C. (205–216° F.); the mass is then transferred to strong woolen bags, which are inclosed by coarse bags made of horse-hair, and these are subjected to a hydraulic pressure of at least 6 atmospheres (90 lb. to 1 inch), at which they are maintained for 20 minutes. The quantity inclosed in each bag is such that the resulting press-cake does not exceed a thickness of 15 millimeters (nearly 5/8 inch), nor a weight of 3½ to 4 kilogrammes. 1,000 parts of American cottonseed yield 489·5 parts of shells, 10·5 of cotton, 365 of press-cake, and 135 of oil.

Crude cottonseed oil has a dirty yellow to reddish color, a spec. grav. of 0·930 at 16° C. (60·8° F.), and congeals at 2–3° C. (35·6–37·4° F.); the refined oil is straw-yellow, and has a spec. grav. of 0·926 at 16° C.—*Dingl. Polyt. J.*

WHITE BRICKS.

A PROCESS is now being carried out, by Clarke & Pickwell, Hull, Eng., for the manufacture of white pressed bricks from common red clays. This process consists in mixing or grinding into the common clay a cheap material—chiefly magnesian limestone—which has been reduced to an impalpable and harmless powder by being burned and slaked. This mixture is passed through a series of mixing and grinding mills, and so completely ground that each particle of each ingredient is brought into close contact with each other. This mixture is then acted upon as it leaves the last mill by an apparatus which reduces it to a fine grain almost like running soil, in which state it falls through the feeder into the moulds of a powerful steam-pressing machine, is subjected to a heavy pressure, and is delivered at the delivery-table a complete and almost dry-pressed brick, which, when burnt in the kiln, produces a white brick of good quality. The ingredients added to the clay at once absorb about forty per cent. of the moisture found in the natural clay, and the grinding is so close and complete that the mixture is thoroughly and evenly amalgamated. The change effected in the color of the red clay on being burnt is due to the presence of the mixture.

GELATINO-BROMIDE PLATES.

By A. J. JARMAN.

As inquiries are constantly made about the gelatino-bromide process, as to how plates can be prepared at home, I will venture to give a method that is sure and, at the same time, easy to manage in the hands of any one possessing a small amount of knowledge in photographic manipulation.

First procure a new tin saucepan, with a close-fitting lid, to hold not less than one gallon of water, and inside the saucepan, on the bottom, solder a piece of tin in the shape of a cross edgewise, so that on it can stand a common earthenware salt jar; around this jar put some water, and also in the jar. Place this upon a three-legged iron stand, and heat carefully with a jet of gas from a common burner, not a gas stove or Bunsen burner, as these give too much heat. The temperature of the water must be raised to about 90° or 100° Fah., but must never exceed 100°. Now procure a common pyrogallic acid one ounce bottle, clean it thoroughly, and wash the cork well; take a piece of linen about four inches square, and place the cork in the center, bring the ends of the linen over the top of the cork, and tie them tightly around the cork with a piece of string. This will enable you to pull the cork out easily, as the gelatine is apt to hold rather tightly. Now take of Nelson's No. 1 or No. 2 gelatine, 210 grains; ammonium bromide, 87 grains. Put both of these into the wide-mouthed pyro bottle, and pour upon them 3 ounces of distilled water; put in the cork and shake well. When this has soaked for fifteen minutes, place it in the earthen jar and put the lid of the saucepan on. Keep this all at 90°, which is easily done by placing a gas-light, not larger than the flame of a night-light, about an inch from the bottom of the saucepan. Put into a glass measure 3 ounces more of distilled water and 130 grains of nitrate of silver; stir well with a glass rod. When dissolved, pour this into a narrow bottle, cork down, and put in the jar of warm water alongside the gelatine. In the course of half an hour take out the pyro bottle containing the bromized gelatine, and shake it up well; wipe the bottle carefully and wrap it up in stout brown paper. Fold the paper under the bottom of the bottle and seal it with sealing wax, also up the side; leave the top undone. Your silver solution is now of the same temperature as the gelatine. Take both into the dark room and pour the silver nitrate solution into the bromized gelatine; put in the cork, and shake vigorously for a few minutes. Twist up the brown paper all over the top of the bottle, cork and all, and place it in the jar; put on the lid, and keep at the before-mentioned temperature for four or five days, shaking well twice a day. Bear in mind it must be kept warm all night as well as all day, and if very great sensitiveness is desired keep it warm for seven or eight days.

The above method of digesting, of course, belongs to Mr. Bennett, and thanks are due to that gentleman for publishing such an admirable discovery. The formula given contains more silver bromide than Mr. Bennett's, although his is an admirable formula when carefully worked.

All being ready now, we take the bottle of emulsion into the dark room and pour its contents into a porcelain pan of about 8½ by 6½ inches capacity, and allow it to set, of course carefully covered up from all actinic light. During the present damp, warm weather I have been obliged to place the emulsion, after it has cooled and still in the pan, on some pieces of ice, so as to get it thoroughly set. This done, the emulsion is cut into pieces and placed in a piece of canvas of the coarsest description, employed by ladies for Berlin wool work. The four corners of the canvas are brought together, twisted up tightly, and carefully, but quickly, drawn through the left hand, and the emulsion that oozes through the canvas allowed to drop into an oblong box, the bottom of which is made of four thicknesses of muslin tacked on. Scrape the emulsion off the hands with a bone knife, and also the remainder of the canvas; put all into the box and pour water from the tap upon the emulsion, and shake it well while the water is running. This must continue for five minutes; then allow it to stand and drain. This done, pour one pint of distilled water over the emulsion, and let it drain again for half an hour. This done, scrape it from the box into a small milk jug; place the jug in warm water and add half an ounce of pure alcohol; stir well with a bone knife and filter into a four-ounce glass measure through a piece of damped muslin doubled into four (say three ounces are filtered). Leave the remainder in the jug to keep warm.

Take a sheet of 32 ounce glass, 3 feet by 1 foot 6 inches, and level it by means of a spirit level and window wedge upon a bench or table; it must be perfectly level, or the gelatine will run all to one end. Suppose three dozen quarter plates are cleaned, take one in the left hand and coat it from the glass measure just like collodion, but do not pour all the emulsion off the plate, for if you do, thin, blurred negatives will be the result. Enough emulsion must be left upon the plate to give it quite an opaque appearance; place it upon the leveled glass and let it set; continue in the same way until the leveled glass is covered, and, when set, put into a drying box to dry. When dry, take one and expose it for a full-length picture (say two or three seconds at the most), and develop with the following:

Freshly-made pyro solution:

Distilled water	2 ounces.
Pyrogallic acid	5 grains.

Have ready, mixed in a bottle, the following:

Liq. ammonia, fort. ·880	½ fluid ounce.
Distilled water	1 "
Bromide of potassium	60 grains.
Bromide of ammonium	30 "

Take 15 minims of this, and let stand ready in a minim measure. Put to your pyro solution one drachm of methylated spirit; place the plate to be developed in a small porcelain pan, and pour on the pyro solution. Keep the pan in motion. Put the 15 minims of ammonia into the measure that held the pyro, and pour from the pan the pyro, and instantly return all over the plate; in from six to twelve seconds a most beautiful negative is the result—in fact, all that one could wish for. Wash off the developer with four ounces of water containing two drachms of methylated spirit, and fix in the following:

Hyposulphite of soda	10 ounces.
Water	20 "
Methylated spirit	2 "

When fixed thoroughly, wash off the hypo with a little of the spirit and water used to wash off the pyro. Place the plate in a pan, and cover it with:

Water	10 ounces.
Spirit methylated	½ (or 1) ounce.

Allow it to soak in this for about five minutes, rocking the dish occasionally. Take out the plate, and drain; then, from an ounce measure, pour on to the plate half an ounce of methylated spirit, pour this on and off for about one minute; stand the plate on its edge on clean blotting-paper, and in ten minutes it is perfectly dry and fit to varnish.

Now, I have found the use of methylated spirit in all the solutions a perfect preventive of frilling. Plates that frill with water alone will not do so anyhow when methylated spirit is employed. This piece of experience I have obtained after using in experiments upwards of one hundred dozen plates.

Now we come to an important part of the gelatine process, *i. e.*, how to intensify a weak negative. With me the following is perfection:

Pyrogallic acid	60 grains.
Citric acid	80 "
Distilled water	12 ounces.

For a quarter-plate, two drachms of the above and two drops of strong nitric acid to six drops of the silver nitrate solution, twenty-five grains to the ounce of water. Let the negative dry first, then moisten it in a pan of clean water; take it out, and immediately pour on the intensifying solution. The dark-room door must be closed. The weak negative will gradually gain in strength, until perfect printing density is obtained, when it may be washed with water, and dried.

With plates prepared with the formula given here, or with Mr. Bennett's formula, I have never known this intensifier to fail.

I sincerely hope that what I have here written will be of great service to those seeking accurate practical information, as it has been gained by a large amount of experience extending over six months.—*Photo. News.*

REASONS FOR PREFERRING DRY PLATES TO WET COLLODION.

WHEN we have employed for so many years with such satisfaction a process which has yielded such fine results as wet collodion, the reasons which should induce us to abandon it and take up something else ought to be conclusive. If the reader will peruse and carefully consider the following reasons I think he will find them very powerful. If they were theoretical only we might doubt; but when we know, as we do, that pictures of the highest quality are daily produced with a fraction of the labor of wet collodion, we cannot refrain to consider the matter in the most careful manner. I claim—

First.—That negatives, portraits, or landscapes can be almost always produced of a quality such as collodion only rarely gives, and under the most favorable circumstances.

Second.—The exposure is only about one-sixth that of wet collodion. The difference between giving four and twenty-four seconds is so great that the advantages are self-evident.

Third.—All the smell, dirt, and discomforts of the dark room are gone.

Fourth.—You can take portraits, and good ones, too, at a time when otherwise you would have to send your sitters away, or else take pictures which would injure your reputation.

Fifth.—You can undertake works that you scarcely ever dare do before, such as large pictures of little children, cabinet groups of children, etc. The labor and uncertainty of such works is reduced to a minimum, because the exposure is momentary instead of being, when large lenses are used, very prolonged.

Sixth.—You can use large, long-focus lenses for small pictures, thus getting many advantages. (Of course you must not attempt this in foggy weather.) The writer uses a 3A lens for almost all work.

Seventh.—You can take on dry plates a large class of subjects, for which with wet plates you would have to transport a quantity of heavy and inconvenient things. For portraits, or groups, *post mortem* pictures, etc., once tried will never be abandoned.

For years the writer has had and used a van fitted up with every conceivable appliance for wet work; but so complete is the change that this is now never used and is never likely to be required again.

But let no one too hastily assume that because these plates are obtained complete and require no preparation they require no special care, and that any one, needing no longer any chemical photographic knowledge, can in a perfunctory manner at once set to work to produce pictures. Nothing but disappointment can possibly follow such a notion. Much has to be unlearned, many erroneous notions to be got rid of, and the whole matter viewed from another standpoint. The one great fact will, however, soon make itself apparent—that by the mind of the operator being free from the ever-present "carking cares" about clean plates, the state of the bath, collodion, and developer, the entire powers are free to be devoted to the higher parts of the art, viz., the artistic.

What an immense advance, then, is here presented to us! All engaged in professional portraiture know right well, to their cost, that the old proverb that "it never rains but it pours" applies to them with painful accuracy. During a considerable period of time they have so few sitters that the keeping on of a staff to relieve the principal of the drudgery of filtering baths, mixing developers, intensifying, etc., is difficult without loss. On the other hand, when business comes it is usually with a rush, and so many sitters come at once that they cannot be attended to properly. But with dry plates the operator has his box of plates ready; after developing one or two he can safely rely on all his plates, and, without danger, place them after exposure in a separate box or division for development at leisure.

I think I hear old collodion operators saying: "Yes! if we could but be sure this is so." These were my own words and belief till I called on a friend who takes forty to fifty sitters daily, one evening being sufficient to develop them after work is over. Having merely to expose during the day, he had been able to take half as many more sittings as would otherwise have been possible.

Look at it again from another point of view, namely, the wear and tear of the slides and camera, and drops of silver on the floor cloth, fingers, and clothes. I have had all my slides carefully cleaned, cased, and varnished. They are now never wetted, and work with a comfort previously unknown. Such articles will last much longer and keep in better condition. With dry plates the hands and clothes remain unsoiled. In the article "On Development" I explain how, after pouring off the wash developer, the plate should be well washed in the tray; it may then be handled and fixed, the fingers being without any stain.

It has for some time past been conceded that landscapes by gelatine emulsion are of the very highest imaginable quality; but the more special references of the writer at the present moment are in regard to portraiture, and his principal object in this communication is to induce his fellow-laborers in the field to make for themselves careful and exhaustive trials, using those precautions which are indicated. He has no doubt that the result must be that they will one and all adopt dry plates. Those who have a bad light in their studio, either in respect of slowness or of artistic qualities, will find advantages in dry plates.

The tendency of these plates is toward half-tone and softness, whereas in collodion it is toward harshness. Contrasts may be broadened, and less softening of the light is required, from the reason I have indicated, namely, that a natural tendency to mellowness exists. Hence, do not let it be supposed that here is indicated any royal road by which fine qualities may be rendered by photographers incompetent to deal with, or properly handle, the higher branches of the art.

Nothing will be changed; there will only be one means the more in the hands of the enterprising and skilled to produce at all times effects which otherwise they would only obtain at times with the finest light. How often have we all felt bitterly, when important sitters were announced, that we were unable to do them full justice because of the poor light! A short time since a royal photographer, an old friend, came down to see what was doing in these new dry plates, whose wonderful qualities were just beginning to be talked about. When he had seen all he said: "Ah! the Duchess of C—— came yesterday afternoon about four o'clock, but there was no light. A dozen friends came with her. She had a train seven yards long. If I had had these plates I could have got all I wanted!" In fact, it would have been worth many pounds to him. For babies, horses, groups, and transparencies for enlarging, to once get these plates into use is to feel you can never do without them.

Just a few words on one item referred to above—transparencies for enlargement. Until you have seen enlargements done by a gelatine transparency from a gelatine negative you have no idea of the perfection of enlarging. Unlike collodion, the films have really no structure, while the coloring, instead of being, like carbon transparencies, a powder in a fine state of division, are an immeasurably finer chemical deposit. Gelatine transparencies are as far before carbon ones as the latter are in advance of the old collodion camera transparencies for enlarging.

One more striking evidence of the usefulness of these plates is that portraits may be readily and most successfully taken in ordinary sitting rooms. What a new and deeply-interesting field of charming occupation for people of leisure and artistic culture is here found! It is very often said that amateurs are not successful in portraits, but the reason is not far to seek. Before they could look for success they had to find a studio or a substitute. This ended the matter; they simply took them in the open air when unable to obtain any means of regulating the extreme power, not to say harshness, of the light. They produced works of the most unsatisfactory nature. This may now be a thing of the past, for by the rapid gelatine dry plates portraits are taken with great rapidity in rooms possessing only the light of ordinary sitting rooms.

It has been held, and by those whose opinion was worth consideration, that an error was committed by photographers in erecting studios of such constructions that the effect of light was one never found under any other circumstances. Of course readers of these lines will at once perceive that it was not from any other reason than dire necessity that our studios as they exist have been built. No doubt can be entertained by thoughtful persons that effects of light and shade (especially the latter) may be looked for, from photographs taken in the light of sitting rooms, of a very interesting character, and possibly having a natural effect such as we have not been accustomed to see. Should such be the case a distinct advance may be claimed for the rapid dry plates.

The plea the writer would desire more almost than any other to enforce is that they tend to facilitate the introduction of the art element. It is surprising that persons should still be found who cling to the notion—that all that is wanted is a clean, powerful printing negative. So far is this from being the case that the public immediately perceive and fully appreciate the art element whenever introduced. Matter-of-fact people—those folks who rather pride themselves, and are thankful they don't require such things as photographs or pictures of any kind—may ridicule artistic, graceful pictures, and demand to be taken "just as I am, you know," in all their natural vulgarity; but let no man doubt that the introduction into his photographs of a fine, cultured taste will soon find appreciation. A great step in enabling him to do this will be the introduction into his daily practice of rapid dry plates, by which he is enabled to concentrate his mind on the highest department, namely, the posing and lighting, while he is free from the grievous troubles of baths, etc.—*Samuel Fry, in British Journal of Photography.*

SOUTHERN CALIFORNIA AS A HEALTH RESORT.

DR. H. GIBBONS, of San Francisco, having recently made an excursion to the southern part of California, for sanitary purposes, records his impressions of that portion of the State in an article in the May number of the *Pacific Medical and Surgical Reporter*, of which he is editor.

He left San Francisco on March 14th, his destination being Los Angeles. His impressions of this spot as a health resort for consumptives were not favorable, although on the whole he believes it to be better than San Francisco. The great feature of Los Angeles is its orange and walnut groves, with which the country is covered for miles around to the south and east, where irrigation is most easy.

After a day or two at Los Angeles, the doctor passed on by rail to Cucamonga, the location of the vineyard which produces the celebrated wine bearing that name. It is thirty-five miles from Los Angeles, eastward, on the northern side of a great valley extending from the "City of the Angels" to San Bernardino, the old city of the Mormons. The valley is from fifteen to twenty miles wide, and skirted by mountains on either side. The climate of the San Bernardino valley has some peculiar features, illustrating the extraordinary diversities presented in this respect by adjacent districts of country over the entire State. The air is generally very dry, the ocean mists never penetrating so far; but the sea breeze is a daily visitor during the summer, precisely to that extent which renders it comfortable and salutary. The maximum heat is lower on the north than on the south border. On the north, the heat of summer is about the same as at Los Angeles, but not oppressive. The southern margin of the valley approaches San Bernardino in temperature, being much hotter than the southern.

The valley is subject to occasional blasts from the north, which come down from the mountain or through the cañons with great violence. There are many localities entirely sheltered from northers. Winter brings no injurious frosts. During the four days that Dr. Gibbons spent here the weather was cold, windy, cloudy, and threatening rain. It was an exceptional period in this respect all over the State. Before leaving home he had a rheumatic affection of the shoulder, to which he had been subject for many years. This not only disappeared before his arrival at Cucamonga, but did not return again, although his feet were often wet for hours and he was constantly exposed to cold and damp. The same may be said of his daughter's cough, which was improved rather than aggravated under climatic conditions from which great mischief might have been anticipated. The people informed him that pulmonary affections were almost unknown along the northern border of the valley, and that malarial disorders never visited the locality, though on the southern border they are common, and at San Bernardino they prevail extensively.

From all his observations and inquiries Dr. Gibbons has no doubt that the foot of the Cucamonga mountain in this valley will afford health resorts not inferior to any other part of the State. At present he is not inclined to specify a given locality, but believes that many localities of superior sanitary qualities will be found in this region, from fifteen to thirty-five miles from Los Angeles.

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YELLOW FEVER.

A recent lecture, delivered by special request, before the Graduating Class of the Medical Department of the University of Pennsylvania.

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IT is not my intention to present to you in this lecture an elaborate history of yellow fever, a work for which neither my time nor my ability would suffice. The few cases of the disease that I have myself seen give me no authority to speak of it from experience. But there are certain questions relating to its origin, propagation, nature, and treatment which an impartial critic may perhaps decide more justly than physicians who have only their personal experience to enlighten them. It is notorious that some reporters of their own observations, not only in our own day, but even in former times, have obscured the subject by confounding together yellow fever and various forms of bilious remittent fever, and notably the malignant and the hæmaturic varieties of this disease.

THE EARLIEST ACCOUNT OF YELLOW FEVER.

It is unquestionable that the earliest account of yellow fever is contained in the histories of the Spanish discoveries and colonization in the West Indies. From them we learn that an epidemic of the disease decimated the Spaniards on their second expedition to St. Domingo at the end of the fifteenth century. During the following century it was elaborately described by the physicians who witnessed its ravages in the French colonies of Guadeloupe, St. Christopher's, and others.

ITS ORIGIN.

From these original centers it was soon carried to Mexico and the other parts of the shores of the gulf of that name, where it certainly prevailed toward the end of the seventeenth century, and various points in North America during the following century. In all these latter places, that is, upon the American continent, there is no reason to believe that yellow fever was ever seen until it was brought thither from the West Indies. In like manner it is certain that until commerce carried it to the eastern and western coasts of South America it was never known in any of the localities which, since then, it has ravaged, and in some of which it appears to have become endemic, as it certainly has at several places on the southern coast of the Gulf of Mexico. But not in all. For example, it was introduced into Dutch Guiana in 1793 and in 1800, and yet subsequently, and for a period of thirty-seven years, it never invaded that province. At the end of this long period of immunity the colony suffered from a new importation of the disease, which annually thereafter visited it for nine or ten successive years, when it ceased, and for the six following years failed to occur. It was then reintroduced by an infected vessel and spread more widely than before. In Brazil, likewise, yellow fever never occurred until it was brought in 1849 by vessels from New Orleans and the West Indies, which infected all the ports at which they touched. From thence the disease traveled inland, causing an immense mortality. On the western coast of South America yellow fever was equally unknown until 1842, when it was introduced by vessels from New Orleans, but it soon afterward became extinct, until ten years later, when it was brought to Lima, in Peru, whence it extended to Valparaiso and other ports of Chili. All of these instances of the spread of yellow fever from the Gulf of Mexico to the coast towns of South America are distinctly traceable to the gold discoveries in California, which drew thousands of emigrants from the States east of the Mississippi, most of whom were passengers on board vessels that either sailed from New Orleans or which tarried at some one or more of the yellow fever centers of the Gulf of Mexico.

THE SEEDS OF TRANSATLANTIC EPIDEMICS IMPORTED FROM AMERICA.

The history of transatlantic epidemics of yellow fever shows that their seeds were imported from America. It was so at Cadiz as early as 1731. But the great epidemic which desolated that city and the surrounding provinces from 1800 to 1804 was still more distinctly traceable to an infected ship from Charleston. Subsequent epidemics in Spain, several of which occurred down to 1828, were as clearly due to importation. It is worthy of notice that the only portion of Europe which was thus subjected to the plague was the one of all others whose commercial relations with the West Indies were the most intimate and frequent. Not only Spain, but other places in Europe where yellow fever has prevailed, furnish similar illustrations, and among them Lisbon, where for more than a century it from time to time occurred extensively and fatally, but always as a consequence of the commerce maintained between that port and the American endemic sources of the disease. On the western coast of Africa it has again and again occurred at several points, and there alone, the remainder of that continent never having known the disease. This fact is evidently and simply to be explained by the constant intercourse of the people of the west coast with the West Indies in the interests of the slave trade.

In North America yellow fever has occurred at such places only as were in communication with one or another of its foci in the West Indies. In Baltimore, Philadelphia, New York, Boston, and all other northern ports the limited epidemics that have occasionally occurred have all, without a single exception, been traceable to vessels or their cargoes arriving from infected ports. Even these rare and limited outbreaks of the disease have grown less frequent and less extensive in proportion to the strictness with which quarantine laws and sanitary regulations have been observed. To such a degree of efficiency have these barriers reached at the port of New York that, although for years past there has been no time during the prevalence of yellow fever in the West Indies when there have not been cases, and sometimes many cases, of it in the quarantine hospital at Staten Island and in the infected ships at that station, there is no instance of the disease having been carried to the city by any vessels, persons, or goods that had passed quarantine.

THE DISEASE HAS NEVER ORIGINATED OUTSIDE OF THE WEST INDIES.

In a word, not a single example can be adduced to prove the origin of yellow fever outside of the West Indies. On rare occasions it has been observed at some of the minor ports of New England, and also in Great Britain and other parts of Northern Europe; but in every such case it was easy to designate the very vessel that brought it from the West Indies; and, although less easy to demonstrate, it is none the less certain, that to a like source may be traced all of the epidemics that have ravaged our Southern States and those of the South American continent. That for some of them a claim of spontaneous or idiopathic origin has been made is well known. But, taking together the facts which prove—1. The ordinary source of yellow fever in importation from the West Indies, 2. The fact that in no single instance can the possibility of such importation be successfully controverted; and 3. The frequent errors of diagnosis committed by physicians who have mistaken various forms of malarial fever for yellow fever—the doctrine of the primary and exclusive origin of the disease in the West Indies receives a full and complete confirmation.

THE CONDITIONS WHICH GENERATE YELLOW FEVER.

What, now, are the peculiar conditions which generate yellow fever in the West Indies? Long-continued heat is certainly one of them, but it is not the sole nor a sufficient cause; for a higher temperature prevails in Africa and Asia, where yellow fever never existed. Neither is moisture, nor animal nor vegetable decay, nor any combination whatever of natural causes, for they all exist as abundantly elsewhere as in the West Indies, without ever generating the disease. Salt water is also essential to its production; for this fever never originates in inland localities, no matter what conditions in regard to heat, moisture, or putrefaction may coincide. These agents may generate malarial fever, but yellow fever never. In not a few instances a vessel sailing from an infected port in the West Indies has proceeded on its voyage for many days, even for several weeks, without accident, until, on opening the hatches, or pumping the bilge water from below the hold, the fever has immediately broken out. In many other cases such a vessel has sailed, it may be, from Havana to one of our own northern ports, or perhaps to Europe; she may have had some cases of the fever on board during the voyage, or, on the other hand, her crew may have remained perfectly healthy. She arrives at a healthy port in hot weather. Her crew disperse, and no one in contact with them contracts the disease. But the vessel's hatches are opened, stevedores belonging to the port unload its cargo, and presently they are all attacked with the fever, as well as the men on board the vessels lying alongside of the infected ship. It is evident that the ship itself, or something in it, but not its crew, was the cause of the outbreak, and equally evident that the morbid poison must have been brought from the port whence the ship came. It is just as certainly generated outside of the human system as that the cause of malarial fever is so, from which, however, it differs essentially in this, that it is portable in a great variety of things, including ships, merchandise, and clothing. When once introduced into a place it does not, like an aerial poison, spread rapidly, and attack the population in every direction as malaria does, but it is first developed around the spot where it first entered, and attacks those only who visit that locality, or who come into contact with fomites which have for some time remained in it. There can be no doubt, in view of the facts already stated and of numberless corroborative ones, that the poison of yellow fever is specific; that its origin is as in the islands of the Gulf of Mexico alone; that it is susceptible of being carried to distant points; and that it is as distinct from all other fever poisons as the plants and the shells of the West Indies are from those of Pennsylvania.

YELLOW FEVER PROVEN TO BE OF LIMITED LOCAL ORIGIN.

The conclusions I have stated are drawn from a multitude of facts, and of themselves would be sufficient to establish the limited local origin of yellow fever and its dissemination by means of a specific poison. But the counter-proof confirms the argument. Yellow fever neither exists endemically in any other place in the world than in those mentioned, nor has it ever prevailed epidemically in any other place into which it was not introduced from its original source. At the present day we hear no more of such epidemics as, a generation or more ago, ravaged certain ports of Europe. Even sporadic cases of the disease no longer occur in them, and yet in all respects save one their sanitary condition is nearly the same as it was when the calamitous invasions of the fever took place. They are more populous, nearly as filthy, their commerce with the West Indies is as intimate, their climatic conditions are unchanged, and yet they are as free from yellow fever epidemics as before America was discovered. The reason of their exemption is simply that they refuse to admit vessels from infected ports until they have been purged of all sources and vehicles of the disease.

THE EFFICACY OF RIGID QUARANTINE.

The precautions which have proved so salutary abroad have been no less effectual in this country whenever they have been honestly and thoroughly taken; and there is every reason to believe that yellow fever would never again since the civil war have entered our southern ports if the quarantine laws had been faithfully executed. During the war, and for some time afterward, yellow fever ceased to appear at New Orleans; and it is certain that the seeds of the recent epidemic were introduced into that city through the neglect, ignorance, or connivance of those who were charged with the duty of protecting the country from this mortal scourge. It is equally well known that, as soon as the nature of the epidemic was recognized in New Orleans, another populous seaboard town peculiarly liable to be infected from New Orleans resolved upon absolute non-intercourse with the City of the Plague, and maintained its isolation throughout the epidemic. In vain it was threatened with a loss of commercial relations by certain influential corporations and individuals; it preferred life to wealth, and closed its port against the carriers of the pestilence who endeavored by force or stratagem to invade its sanitary line. It was rewarded by the result, for not a single case of yellow fever occurred in that city, while its less wise and prudent sisters in Louisiana, Mississippi, and Tennessee, who received the fugitives from New Orleans, were severely scourged.

The efficacy of duly executed quarantine laws is nowhere more distinctly displayed than by their administration at the port of New York, where, it is stated, more cases of yellow fever arrive between the months of July and October than at all the other ports of the United States. "During this period there is a daily average arrival of one or two infected

vessels, and yet at no time for a number of years has the yellow fever made its appearance in that city." "This statement must go side by side with the one that New York, during its summer season, is as much exposed as New Orleans during the corresponding period."

CIRCUMSTANCES INFLUENCING THE DIFFUSION AND FATALITY OF YELLOW FEVER.

The circumstances or conditions which influence the diffusion, the grade, and the mortality of yellow fever are peculiar, and differ from those relating to every other disease. It is well known that malarial fevers attack the same individuals year after year, the natives of the locality where they prevail as well as strangers; but yellow fever is apt to spare the natives of places where it is endemic, and very seldom attacks the same person more than once. Even in cities like our Southern seaports, where the disease occurs only through importation, one attack is apt to render its subjects invulnerable during subsequent epidemics. Still more than this, the natives of warm climates who go to reside in the yellow fever region are not nearly as liable to the graver forms of the disease as are the natives of colder climates; and it has long been noticed that during its epidemics the mortality is extremely great among the latter class of persons and relatively small among the former. But neither will being a native of such a place, nor a long acclimation, secure an absolute immunity from the disease. Like typhus and typhoid and eruptive fevers, it is occasionally liable to attack those who have already paid tribute to it. During epidemics of an exceptional degree of violence or malignity such cases are not uncommon. Moreover, the immunity is very apt to be forfeited by natives of yellow fever localities who have resided long enough in a cool climate to undergo a certain change of constitution. On returning to their native places they are hardly less liable than original foreigners to be attacked.

THE COMPARATIVE IMMUNITY OF THE COLORED RACE.

A remarkable difference of susceptibility to yellow fever exists between the white and colored races. Observers in the West Indies, and in our Southern States before the civil war, are agreed that the latter race was almost entirely exempt from its attacks, and several affirm that no negro from the coast of Africa was ever affected by it. Even among colored persons born in this country the liability has been comparatively small, and the type of the disease much milder than in whites. It is not without interest that the negro race enjoys a similar immunity from periodical fever also, and especially from that grade of it which, from its malignant type, has sometimes been confounded with yellow fever, while they are more liable than the whites to other epidemic diseases, such as typhus, typhoid, and eruptive fevers and cholera, and suffer a greater mortality from them. It seems probable, therefore, that their immunity to yellow fever is innate and constitutional. But as it is well known that negroes bred in the northern portion of the Southern States are more liable to the disease, and especially to its graver forms, than those who have always lived in the seaboard towns, it seems probable that mere diversity of race, apart from climatic peculiarities, is insufficient to account for the relative insusceptibility of the Southern negro to this disease. When we associate these facts with the one before mentioned, that foreigners are apt to contract the disease in proportion as they belong to cooler climates than that of the West Indies, we are led to suspect that the immunity of negroes is in some manner related to the great functional activity of their skin, which is proper to all natives of the torrid zone, but in the highest degree to the dark races, and which enables them to exhale the specific poisons of malarial and yellow fevers, while natives of cooler climates, being but feebly provided with such an eliminative faculty, fall victims to these diseases.

THE ESSENTIAL CAUSE OF YELLOW FEVER (?).

Such, in the briefest terms, is a history of the conditions under which yellow fever arises, but they shed no light upon the nature of its essential cause. So far as we know, there is not any single climatic, meteorological, or telluric agency which is known to be peculiar to the cradle of the disease, nor any degree or combination of such visible agencies as are met with in the West Indies, that are not even more rife in thousands of places in Africa and Asia which yellow fever never visited. In default of any demonstrable and real cause, the usual refuge of ignorance has been eagerly sought for by theorists who are not content to seem ignorant of anything. They attempt to blind themselves and us with a cloud of words which describe or define nothing, and which, when reduced to their simplest expression, read "zymotic poison." Upon calm reflection, this phrase turns out to be little else than "words without knowledge." At the best it can only mean that a certain specific poison must be received into the system to produce yellow fever, as a certain other morbid poison must be absorbed to generate typhus, another small-pox, and so on, a proposition which no well-informed physician can deny, but which leaves us as ignorant as ever of the specific cause of yellow fever. They neither tell us what it is, whence it proceeds, how it acts, nor wherein it differs from other morbid poisons; in fact, leave us quite as ignorant as when they undertook to instruct us.

A search after the organic germs which the zymotic theory calls for has been diligently made, but until recently no plausible claim to their discovery has been advanced. Since the late epidemic this has been done by Prof. J. G. Richardson, of this University, and Dr. Robert White, of the U. S. Marine Hospital Service. After examining specimens from yellow fever patients dying in Louisville, Memphis, Mobile, and New Orleans, they believe they have discovered that the uriniferous tubules of the kidneys are often choked with a fungous growth which mechanically obstructs the outflow of the renal secretion, and thus causes the diminution or complete suppression of urine, which constitutes such a common and fatal symptom of the disease. They also think that similar groups of fungoid spores (micrococci) frequently form in the hepatic ducts, and, by interfering with the free secretion of bile, give rise to the yellowness of the skin, from which the name of yellow fever is derived. They report that the fresh blood of yellow fever patients, sealed up in tubes, and fastened to microscopic slides, so as to be readily examined with a power of 800 diameters, shows a fungous growth differing somewhat from that developed under similar conditions in normal blood, but consider that their experiments are too few in number as yet to form the basis of any positive statement in regard to the presence of spores or germs in the circulating fluid of persons affected with this disease.

THE GERM-ORIGIN THEORY NOT PROVEN.

The hypothesis of the origin of yellow fever in specific microscopic germs is a very old one, and the arguments in its favor and against it were summed up by La Roche in his great work on yellow fever as long ago as 1855. Ten years later an English writer assumed that the virus of this disease and all "primary zymotic poisons owe their origin to the development of the humbler and more minute, and, therefore, more subtle forms of animal and vegetable life." The ground of the claim made by the microscopists whom I have named is that they have demonstrated what before them was only supposed to exist. But, admitting the facts which they have brought to light, that the renal and the biliary ducts and the blood of persons who have died of yellow fever are filled with the organisms they describe, we shall await with interest the counter-proof that similar organisms are not found in malarial fever and other so-called zymotic diseases. Until then we cannot admit that they have demonstrated that any such condition as they describe is peculiar to yellow fever. To adduce the presence of these organisms in the biliary ducts as a cause of the jaundice in this disease is to overlook the capital fact that in yellow fever, so far from there being an accumulation of bile in that organ, it is singularly pale through the absence of blood from its vessels and of bile from its ducts, and that the characteristic jaundice of the disease is due to the suppression of the secretion of bile and not to its retention in the liver. In regard to the accumulation of fungoid spores in the tubules of the kidneys as a cause of the alleged "diminution or suppression of urine, which is said to be such a common and fatal symptom of the disease," it must be remarked that this statement is not borne out by clinical observation, nor is it consistent with what we know of the effects of suppression of urine in other diseases. Renal obstruction occasions convulsion or deep stupor, a totally different condition from that which characterizes the ordinary mode of death from yellow fever. It is often a state of conscious resignation, or of apathetic indifference, or of a cheerful, delirious reverie, and even when the coma is profound it is not so uninterruptedly, but often alternates with delirium. These are not the phenomena of uræmia.

DEATH NOT CAUSED BY URÆMIA.

While it is very certain that suppression of urine is generally a fatal sign, it is equally so that death in this disease constantly occurs independently of any such symptom and while the urine is freely secreted. In certain epidemics a majority of fatal cases present this symptom, but in others it is not the uniform, nor even the usual precursor of death. It follows, therefore, that neither uræmic symptoms, nor suppression of urine, nor the assumed cause of their production, can be accepted as a sufficient explanation of the phenomena of the disease. It should not be lost sight of that obstruction of the kidneys, as a cause of suppression of the urine and of uræmic symptoms in this disease, is a generally accepted pathological fact; but pathologists have hitherto recognized as the cause of the obstruction an infarction of the renal tubules with desquamated epithelium, which they did not discern hypothetically, but demonstrated with the microscope.

THE CONTAGIOUSNESS OF YELLOW FEVER.

Having thus sketched an outline of our knowledge of the origin, diffusion, and essential cause of yellow fever, there remains to be noticed the question of its contagiousness, *i. e.*, its propagation by something generated in and emanating from the body of the sick, and conveyed to the well by direct contact or indirect communication with them through any medium whatever. These are the essential conditions of contagion as we see it illustrated in the dissemination of small pox, measles, scarlet fever typhus, and typhoid fevers. Yellow fever is not propagated in this manner. In a circular issued by the Surgeon-General of the U. S. Marine Hospital Service in September last, it is stated that "yellow fever patients have been treated in the Marine Hospitals at St. Louis, Cairo, Louisville, and Cincinnati, without communicating the disease, the simple precaution having been taken to disinfect the clothing and other effects immediately on receiving the patients. It is a well-known fact that the unacclimated attendants upon the yellow fever patients at the New York quarantine do not contract the disease." And the Surgeon-General is justified in adding that "yellow fever is transported by *things*, and not from persons considered apart from their clothing." A similar judgment has been pronounced by all physicians residing in our yellow fever cities, whose professional rank entitles their judgment to the greatest weight.

PROOFS OF ITS NON-CONTAGIOUSNESS.

The late Dr. Nott, who spent nearly all of his professional life in Mobile, and whose competency in such a question no one will doubt, states his judgment thus: "Yellow fever is not generated in the human system, *nor transmitted from one person to another in any way;* its germ or poison is generated outside of the human system, and is taken into the system after the manner of the marsh malaria poison. But, unlike the latter, its germ is portable, and may be carried from one point to another, and thus propagated." And again he says: "Few of the old and experienced physicians of the yellow fever zone believe in the contagiousness of the disease, and their convictions are based upon facts coming under their observation. During thirty years' residence in Mobile my experience corresponded with theirs."

The late Dr. Warren Stone, of New Orleans, who probably had more experience of yellow fever than any man who ever lived, stated emphatically the exact truth when he declared, "I am perfectly convinced, beyond all doubt or hesitation, that, personally, it is not contagious; I *know* that it is not." In this city, at various times during nearly a century, local epidemics of yellow fever have occurred from time to time, every one of which was distinctly traceable to vessels from infected ports. Many of the patients were received into our ordinary hospitals, and perhaps not always with due care to leave behind their infected clothing; and yet in no single instance has the disease attacked their attendants or the surrounding hospital patients. Similar illustrations without number might be cited to prove the absolute incommunicability of the disease from the sick to the well. It would be very instructive to contrast with these facts innumerable others in which yellow fever was introduced into healthy ports by vessels on board of which not a single person had at any time during the voyage suffered from the disease, showing that, although not contagious, its cause is highly infectious.

IT IS AN INFECTIOUS DISEASE.

This distinction is not a deduction from scientific principles, nor is it a convenient hypothesis; it is a plain lesson taught by plain facts, which, however, it required a modicum of common sense to interpret, seeing how difficult it is to distinguish between the agency of a ship and of its crew, and between people and their clothing. But the truth has been made plain by the results of quarantine already adverted to. When the ship and its cargo, its crew and its passengers, have been purified of the perilous stuff they brought with them from yellow fever ports, they have become harmless in our docks and our houses.

These plain and well established lessons were unheeded in the summer of 1878 at the port of New Orleans. Infected persons and goods found their way into the city, and in due time the germs which they introduced multiplied and spread the disease throughout the city. The panic-stricken people sought refuge in flight, and they with their infected goods spread the infection along the line of their exodus, eastward and northward to the Ohio river and beyond it, until nearly fifteen thousand persons were sacrificed to the incompetency or connivance of those officials whose duty it was to protect the country against the entrance of the destroyer. And yet in all this desolation we do not learn that anything has occurred to prove the personal contagiousness of yellow fever. As a single illustration of the mode in which it spread, I may cite the case of Grenada, Miss., a town of 2,500 inhabitants, of whom 1,040 were attacked with the fever, and 326, or more than 30 per cent., died. The fever first broke out in a family of which the mother had been to the railroad depot to see her daughter off to a neighboring town. The train was from New Orleans, where the fever was then raging, and the mother, it is thought, occupied a seat in the railroad car alongside of her daughter for about twenty minutes, while the New Orleans passengers were taking breakfast.

THE RAPIDITY OF DIFFUSION OF THE YELLOW FEVER POISON.

In the history of the late epidemic, as of many previous ones, there is much to illustrate the rapidity and extent of diffusion of the yellow fever poison. These qualities seemed to lend a strong probability to the zymotic hypothesis of the disease, for they seem to resemble those of fermentation as it occurs in certain liquids and in bread dough. "A little leaven leaveneth the whole lump," and a single infected bale of goods or garment may infect a whole city. The disease was introduced into New Orleans as early as May 23d, 1878, and before July 12th, thirty or forty deaths from it had occurred, the reports of which were at the time suppressed. It broke out in the form of a series of groups of cases, each being connected with some other by personal association or by exposure in the same locality, and from these separate foci the conflagration spread over the whole city. Thence it was carried "in the clothing or about the persons of people going from the infected districts. In other instances it was conveyed in such fomites as cotton bagging, or goods of some description, or bedding and blankets." (Dr. Bemiss' Report.)

A LOW TEMPERATURE STOPS THE PROGRESS OF THE FEVER.

Finally, as a high temperature is necessary to develop the disease from its germs, so a low temperature suspends or destroys their activity and arrests the progress of yellow fever epidemics. You must have noticed that on the first occurrence of frost the spread of the recent epidemic abruptly ceased, first upon the northern limits of the area within which it had prevailed, and rapidly thereafter at points more and more southwardly, until at last it ceased in New Orleans. But experience has shown that in this way it is not always absolutely killed, that its activity may be only suspended, and that where it has prevailed in the autumn it will perhaps reappear the following year at the same season if the weather favors its revival. In that case it usually assumes a milder type, and may even reappear once more with lessened virulence the succeeding year, or until it fades entirely away. Again, a transient period of cold weather does not always put an end to an epidemic of yellow fever; if the temperature rises again the disease may break out anew. But it should be remembered that even in our Southern seaboard cities the subsidence of an epidemic is not always delayed until frost, and in Cuba, where frost is unknown, yellow fever subsides, like other epidemics elsewhere, for want of food to feed on, since all who are susceptible of having the disease have already paid their tribute to it.

THE PATHOLOGY OF YELLOW FEVER.

Having thus sketched the conditions under which yellow fever arises and prevails, we might proceed to consider the symptoms which characterize it. To render them intelligible, however, we should first learn what alterations of function and structure the disease occasions in the organs that exhibit its distinctive symptoms. The symptoms point directly to the blood, the stomach, and the kidneys as organs which are most deranged in their structure, and so, in point of fact, they are. When venesection was practiced in the treatment of yellow fever it was observed that the coagulability of the blood was diminished in proportion to the gravity of the attack, and that the serum was yellowish or reddish yellow; it has shown more recently that its natural alkalinity has been replaced by acidity; that it generally contains a notable proportion of urea, especially in the advanced stages of the disease and after death; indeed, according to one observer, "it is seventy times more abundant in yellow fever blood than in normal healthy blood" (Jones). According to the same author, Dr. Joseph Jones, cases attended with suppression of urine are "characterized chiefly by great diminution of the fibrin, which, in some cases, he found to be not one-hundredth of the usual amount, and by the abnormal amounts of urea and ammonia, and of the sulphates, phosphates, and extractive matters." He was unable, "even after the most diligent search with the highest magnifying powers, to discover in the fresh blood of yellow fever patients any living animalcula, or vegetable cells, or sporules, or pigment granules." The latter statement should be weighed against that of Drs. Richardson and White, who detected an obstruction of the kidneys by fungoid spores. As to the microscopical appearances of the blood itself, there is no doubt that a large proportion of the red corpuscles is found to be loosely scattered instead of forming rouleaus, and that many are also disintegrated, the degree of these changes varying with the malignity of the disease.

THE BLACK VOMIT—ITS EXPLANATION.

Identical, but more complete, changes are found in the blood that constitutes the black vomit. It is not always black at first. It is due to two causes, the liquefaction or disorganization of the blood, and the inflamed and softened condition of the gastric mucous membrane. Vomiting in this disease is at first bloodless, and is due to inflammation of the stomach. As the liver secretes but little bile, the rejected fluid is watery and mucous, and has at first an alkaline reaction. But later it becomes acid, and is shown by appropriate tests to contain muriatic acid. Its acidity is so great that it creates an acrid, burning sensation in the throat and stomach, and continues to do so even after basins of it

have been vomited. When allowed to settle the vomit separates into two portions, of which the lower is grumous and almost black, and the upper is as clear as pure water. On microscopical examination the deposit is found to consist of loose and disintegrated red-blood cells. "No animalcula are discoverable in either fresh or putrescent black vomit; but as it decomposes certain fungi are disclosed, which are most frequently, if not always, developed outside of the body during fermentation" (Dr. M. Michel). Urea is said to have been found in the contents of the stomach. The condition of the stomach is inflammatory, with a greater or less tendency to softening of its mucous coat. Sometimes it is of a deep brown color, from the blood accumulated in its veins, and altered by the acid contents of the organ. When the black vomit has been copious the vessels of the stomach are empty and the mucous membrane pale. Specks or spots formed by ecchymoses, or effused blood, are often observed. The organ usually contains more or less of the "black vomit," varying in quantity from three or four ounces to a pint. It deserves notice that the inflammation of the stomach is pretty equally diffused throughout its mucous coat, and that there is no evidence that its glandular apparatus is specially involved. In this respect the condition of the organ contrasts remarkably with its state in remittent fever, in which disease the mucous glands of the organ at its pyloric end are greatly enlarged.

THE LIVER IN YELLOW FEVER.

Not less dissimilar is the liver in yellow fever from that which occurs in remittent fever. In the latter the organ is enlarged, distended with blood and with bile, and presents a characteristic dark bronze color; but in yellow fever the organ is pale, and appears to be devoid of even its normal proportions of bile and blood. This peculiar appearance was first described by Louis, in his account of the epidemic at Gibraltar, in 1828, as "being sometimes of the color of fresh butter, sometimes of a straw color, sometimes of the color of coffee and milk, sometimes of a yellowish gum, mustard, or orange color." The change may probably be ascribed to a drainage of the blood of the liver into the stomach; it is nowise a fatty degeneration, for in that condition the cohesion of the liver is softened, whereas in this it is increased or unaffected. To whatever cause it may be due, it is certainly peculiar to yellow fever. The gall-bladder is usually empty, or contains only a little viscid bile. These facts harmonize with the presence of an excessive quantity of biliary coloring matter in the blood, the urine, the skin, and other tissues.

The kidneys do not present in their general aspect any characteristic appearances. Like the other tissues, they are yellow, but they are neither enlarged nor softened. On microscopic examination they present only the ordinary lesions of desquamative nephritis in their tubular portions—that is to say, the tubules are distended with epithelium, and more or less with albuminous casts. But this infarction of the organs is sufficient to account, in part at least, for the albuminous quality of the urine in the disease, and for the presence of so large a proportion of urea in the blood.

No other lesions found after death in this disease appear to be related to its symptoms. In the cerebro-spinal centers no alteration is observed, except, perhaps, venous engorgement. The spleen is not enlarged, nor is it softened out of proportion to the other tissues. Half a century ago Louis described the heart as being flabby, with diminished cohesion of its muscular tissue. Riddell and others long ago laid much stress upon the pretty constant molecular degeneration; and quite recently Dr Joseph Jones claims to have determined, both by chemical analysis and microscopical examination, that the heart undergoes acute fatty degeneration in yellow fever. However this may be, it is very certain that during life no symptoms point to any special debility of the heart such as would be occasioned by such a lesion. Indeed, "it has been known to preserve an apparently normal state, even coincidently with other portentous symptoms; and the pulsations of the heart may continue some time after all the respiratory movements have ceased." This clinical fact is of greater weight in establishing the essential integrity of the heart-muscle in this disease than any number of microscopical observations that go to demonstrate the degeneration of its tissue are in proving the organ to be functionally incapable.

A SUMMARY OF THE GROUND THUS FAR GONE OVER.

The following propositions would seem to follow, if what I have thus far laid down be true:

1. That yellow fever originates nowhere but in the West Indies.
2. That its morbid poison is conveyed elsewhere in ships and fomites.
3. That, wherever conveyed, a high temperature is essential to its propagation.
4. That a strict quarantine is always efficient in preventing its dissemination.
5. That it is not contagious.
6. That its essential cause cannot be isolated or defined, but must be assumed to be a specific poison.
7. That this poison in the system acts primarily in two ways: by disintegrating the blood and inflaming the stomach; and that, secondarily, it tends to impair the eliminating function of the kidneys.

THE FORMS OF YELLOW FEVER.

Having endeavored, thus far, to place before you an outline of the origin, modes of extension, and anatomical characters of yellow fever, I shall now attempt to complete the picture by a succinct account of its clinical history. Like all other febrile diseases, and especially like the other fevers distinctively so called, yellow fever assumes numerous types, of each of which several grades may be recognized. It would confuse rather than throw light upon the subject were I to attempt to depict these various forms, which, indeed, are not more peculiar to this than to any other fever that occurs epidemically, and which, presumably, depend upon the greater or less concentration of the febrile poison, the quantity of it absorbed, the condition of the persons attacked, and various other circumstances. I shall, therefore, select the most ordinary type of the disease as the basis of my description, and incidentally point out the most usual deviations from it which are apt to be met with.

THE SYMPTOMS OF INFLAMMATORY YELLOW FEVER.

The common or typical form is inflammatory. In it the symptoms present themselves in an orderly succession. The earliest are those of other fevers: loss of appetite, debility, even faintness, and depression, physical and mental. To these are added vomiting, gastric irritability, a hot skin, and severe pain in the head, back, and limbs. The pain in the head is very characteristic; it is excruciating, darting from temple to temple. The face is usually flushed, the eyes are injected (ferrety), watery, staring, and the skin intensely hot (106°–107°) all over, or else in some places is cool, showing the deceptive character of the heat. The pulse is full and hard, ranging from 90 to 120.

The rapidity with which the temperature reaches its acme is a peculiarity of yellow fever, and the more rapidly it does so the greater is the danger to life.

The mind is usually clear, but sometimes there is delirium or sopor.

The general excitement is followed rapidly by gastric disturbance, by retching and vomiting of mucus, first; then of bile, the reaction being alkaline; then of a pale, watery, and very acid liquid. As this proceeds the epigastrium becomes tender and stomach irritable, rejecting everything with straining efforts, and burning pain is felt within it. Cold drinks are eagerly craved, but are speedily vomited. These symptoms prove the existence of a gastritis. The urine diminishes, and is albuminous.

The phenomena now described vary with different epidemics and individual cases; they last for a few hours or for several days, and then remit, the more gradually the better. The pains in the head and back subside, the feeling of distress and anxiety is less severe, the pulse less frequent, and also feebler; the skin is moister and cooler, its temperature reaching even the normal grade or falling below it; the vomiting is less urgent. If recovery is to follow, these symptoms slowly disappear, leaving the patient exhausted. But if the tendency is to a fatal issue, the remission is less complete; the patient, indeed, is comforted by his respite, but the attentive physician observes that the heat, the pulse, the vomiting, the look of distress continue. At this period, often, the yellowness appears, or becomes darker, upon skin of the face, chest, and limbs successively. In the matters vomited little black specks begin to be seen. The vomiting grows more constant, the throat is scalded by it, and straining is followed by regurgitation of a large quantity of dark granular matter. This is the black vomit. It ushers in the third stage, in which death occurs in different ways, but usually by collapse, or by coma. The patient may grow rapidly weaker from the vomiting and nervous prostration, while the mind remains nearly unclouded, the pulse sinking, the skin growing cold and clammy, and, in depending parts, purplish. Or again, there may be active delirium, amounting even to frenzy, or, on the other hand, stupor or coma, while the debility grows more decided, the yellow tinge of the skin more intense, the "black vomit" is thrown up, or regurgitated, almost continuously; blood sometimes exudes from the mouth and fauces, and from the vulva in females; the stools are liquid and very dark, from blood, and death takes place by combined exhaustion and oppression, the heart still beating after the pulse has ceased.

Coma or exhaustion may precede death even when there is no black vomit. In some cases this is retained in the stomach.

It should be remarked, also, that in fatal cases of this, as of other fevers, the temperature may rise considerably on the approach of death, and even after death.

Some of these symptoms are associated with, if not due to, the suspension of the eliminating function of the kidneys, to that condition known as uræmia.

The tendency to suppression of the urine in this disease has long been known. During the first two or three days of the attack its quantity is somewhat diminished and its color dark. From third to fifth day, especially in cases tending to terminate fatally, it may diminish still more, or even be suppressed; if this state continues the issue is necessarily fatal. About the fourth day, bladder epithelium is found in the urine, and soon afterward solid transparent casts of renal tubuli. These substances are usually stained with blood, and the urine is of a corresponding color, but blood-disks are rarely met with. When they are found, a true hemorrhage has taken place; and this is less unfavorable than the presence of the hæmatin of the blood alone, for the latter denotes a profoundly disorganized condition of the blood.

The urine, as before remarked, is generally coagulable by heat, proving it to contain either albumen or globulin, and the change is observed at an early period in fatal cases. This circumstance is extremely rare in malarial fevers. Biliary coloring matter frequently tinges the urine deeply. Urea is diminished in this secretion, while ammonia is copiously exhaled by the skin and breath, as in other cases of the typhoid state, accompanied with uræmic symptoms. The chlorides are diminished.

The alvine evacuations are at first feculent and mucous, and very fetid; they then become more liquid and of a lighter color, and deposit a dirty gray sediment, composed chiefly of mucus and serum, and epithelial scales; they contain crystals of the triple phosphates (of lime and magnesia) with uric acid, and little granules of opaque black matter formed of altered blood pigment. Still later, they consist of scanty mucus, which is either clear, or is tinged yellow by the bile, or else brown or black by the blood. The bloody stools are sometimes identical in appearance with the black vomit. The light or clay-colored stools owe their appearance not only to the absence of bile, but to a defective elimination by the colon of the substance which ordinarily gives the fæces their characteristic color.

Thus it appears that the effete materials of nutrition which are naturally eliminated by the liver, the colon, and the kidneys are, to a greater or less extent, retained in the blood, and we may, therefore, infer that they have some share in causing the disorganization of that fluid, destroying or impairing the life of its globules, and therefore contributing to develop and intensify the mischief produced by the specific and material poison which is the essential cause of yellow fever.

The successive phenomena of an attack of yellow fever, as they have now been presented, show that it is a fever of one paroxysm, consisting of three stages, which are more or less marked, according to the gravity of the type of the attack, and by its termination in recovery or death. In the first stage the symptoms are febrile, nervous, and inflammatory. In the second there is a remission or subsidence of the symptoms more or less distinctly marked. In the third the phenomena either decline until recovery takes place, or increase in gravity until death. The second stage, or that of partial remission, is apt to deceive novices, who suppose that it is the commencement of convalescence in all cases; whereas, it is in a large proportion only an ineffectual rally against the effects of a mortal poison. Even after convalescence is established the danger is not entirely passed; some exposure, fatigue, or imprudence in eating may develop the disease anew, with fatal consequences. In all cases the convalescence is tedious; the appetite and digestion continue feeble; boils and circumscribed phlegmonous ulcers occur after some epidemics. These facts show: 1, that the specific poison may lurk in the system, even after its first explosive demonstration; and 2, that the same poison has profoundly modified the blood, and that the local gastric lesions require time for their repair.

THE MALIGNANT TYPE OF THE DISEASE.

In this sketch of the successive stages of the disease those cases are necessarily taken as models which run through its entire course; but it must be remembered that yellow fever, like other "zymotic" diseases, may assume such a malignant type as to terminate fatally before the stage of remission is reached. As in typhus and in scarlet fever, death may occur in the first stage, which then presents the characteristic phenomena of devitalization and disintegration of the blood. Profuse vomiting and sometimes purging of altered blood may take place, the urine also is bloody, in females blood flows from the vagina, and subcutaneous ecchymoses disfigure the skin. These are the cases which so conspicuously demonstrate the material nature of the poison of yellow fever.

THE PROGNOSIS OF YELLOW FEVER.

It may be considered favorable when, with a pulse not exceeding 110 and of a moderate force, the epigastric tenderness is not excessive, and the irritability of the stomach subsides with the fever; and when the urine is not suppressed or greatly diminished, nor contains much albumen. The unfavorable symptoms are those which indicate either violent excitement of the brain, or, on the other hand, its oppression or exhaustion; they are intense gastric distress and black vomit; bloody (black) stools; urine suppressed, strongly albuminous, or loaded with casts of the renal tubules; great dejection or torpor of expression; the patient's indifference to the result; insensibility of the skin, whether it remain dry or become moist and flaccid; and also the appearance of dark petechiæ or ecchymoses.

Mortality.—It varies exceedingly in different epidemics, and this fact is too often forgotten in estimating the value of different methods of treatment; *e. g.*, in 1847, at Mobile, the mortality was 8 per cent., and at New Orleans 12 per cent., and in the latter city, in 1867, at least among the military, it was 15 per cent. According to the published accounts of the recent epidemic (of 1878) the mortality reached about 33 per cent.

On the other hand, at Seville, in 1800, one-sixth of the whole population was destroyed; at Barcelona, in 1821, among hospital patients it reached 90 per cent., and in Philadelphia, in 1853, the proportion of deaths was 75 per cent. of those attacked.

In general, the relative mortality, or the ratio of deaths to cases, is greatest in new seats of the disease and among unacclimated persons in the localities where the fever ordinarily prevails.

THE DIAGNOSIS OF YELLOW FEVER.

The only disease liable to be confounded with yellow fever is bilious remittent fever. But the differences between the two are well defined.

Yellow fever occurs in towns, usually seaports, or breaks out in ships at sea.	*Bilious fever* prevails in the country, by fresh water streams, lakes, and marshes.
Prevails in hot latitudes and in hot seasons.	In temperate as well as hot latitudes, and, in great part, beyond yellow fever limits.
Arises usually during the hottest weather—	Occurs when the nights have become cool—
Only in and near the Gulf of Mexico; never originates in Europe, Asia, Africa, or on the Pacific shore of America.	All over the world, except in very cold climates.
Seldom attacks the acclimated.	Attacks acclimated and non-acclimated alike.
Rarely more than one attack.	One predisposes to others.
Mortality large, sometimes very, whatever the treatment.	Mortality small where a specific treatment is used.
Jaundice rarely absent, and is of a lemon color usually.	Jaundice often absent, and generally of an orange tint.
Is preceded by injection of face and eyes.	Not preceded by any hyperæmia of skin.
Hemorrhage—from stomach and various organs; very rarely from kidneys.	Hemorrhage—very rarely from stomach; in some epidemics from kidneys; rarely elsewhere.
Black, following acid, watery vomit.	Bilious vomiting.
Yellow liver.	Bronze liver.
Spleen not enlarged.	Spleen enlarged.
Suppression of urine and albuminuria. It contains no bile.	No suppression of urine, and albuminuria slight, if any. Contains a great deal of bile.
No characteristic sequelæ.	A marked and peculiar cachexia.
Communicability by fomites impregnated with miasm.	Not communicable at all.
Quinia does not prevent or control it.	Quinia is both a prophylactic and an antidote.

THE TREATMENT OF YELLOW FEVER.

In the first place, there is no specific cure for this disease. In the next place, the gravity of epidemics varies extremely, and a remedy which seemed successful in one, may utterly fail in another. Again, in the milder forms of yellow fever, as in such forms of many other diseases, patients will survive a vast deal of injudicious treatment. History shows that in yellow fever the most sanguinary depletion, the most violent purgation, the poisonous operation even of mercury given to salivation, have all proved less mischievous in their effects than might have been suspected—so wonderful is the tenacity with which life clings to our mortal frame; so gallantly does it sometimes come out of the fight when even false science and unskillfulness are leagued against it.

It is just as true in yellow fever as it is in other grave fevers that some patients are inevitably doomed from the beginning; so that neither tender and judicious nursing, nor therapeutical skill, nor the blundering force of heroical drugging can rescue them from death. Some attacks, again, are so mild that they need only the enforcement of rest, quiet, and proper food, with prudence afterward, to secure the perfect recovery of the patients. In certain epidemics, the one class of cases, and in certain others the opposite class predominates, and it is for the sagacious physician to discriminate them and to act accordingly. Like other diseases, also, the type of yellow fever may vary, at one time partaking more or less of the sthenic or inflammatory character, and at another time exhibiting the phenomena of the typhoid state. Under such contrasted conditions, it is evident that routine methods of treatment cannot be appropriate.

Physicians who encounter yellow fever for the first time, and those especially who are not familiar with its peculiarities, are almost sure to imagine that they can combat it successfully by some heroic method. But, if they are men of a teachable spirit, they soon learn prudence in the school of experience, and reserve their cups and lancets, their pills and potions, their blisters and sedatives, and douches and salivants, for some field in which there is more hope of their doing good, and less fear of doing mischief than in yellow fever.

NO SPECIFIC FOR YELLOW FEVER.

There is no specific remedy for yellow fever, and the only successful treatment of it is the one which is indicated and determined by the special symptoms of each individual case. That which I shall briefly sketch is the method of those who have learned at the bedside to subordinate theory to practice, and reasoning to experience.

In the first stage, if the reaction is high, with muscular pains, headache, an active pulse, ferrety eyes, and thirst, the patient should be put to bed, and kept there in perfect repose. The feet should be immersed in a warm mustard foot bath, at about blood heat; if the gastric uneasiness is marked, a mustard plaster should be laid on the pit of the stomach; cool acidulated drinks given in moderate quantities, and a tendency to perspiration promoted by warm bed clothing. Great care must be taken to prevent the perspiration from being checked. It may be proper to administer half an ounce of castor oil, if the bowels are confined, but not otherwise, and not as a matter of routine. Its operation may be promoted by large enemata of soap suds. Some physicians of great experience have found that at this stage a dose of quinia, of eight to ten grains, has a very happy effect in relieving the muscular pains and the aching in the back, and that it diminishes restlessness and promotes sleep. It should, at least, be tried, for it can do no harm, and may be the means of turning the tide in the patient's favor.

The use of quinia as a specific antidote for yellow, as it is used for periodical fevers has been advocated by a good many physicians; but it now appears settled that their judgment was erroneous, and the result either of their mistaking bilious, or hemorrhagic, malarial fever for yellow fever, or else of the tolerance manifested toward all descriptions of treatment in some epidemics of yellow fever of a mild but sthenic type.

In the second stage, or that of remission, if the symptoms are mild, nothing is required to be done but to maintain the bodily and mental rest of the patient, and to administer food appropriate to his condition, such as delicate animal broths, if possible, and in small quantities at a time, or else milk and farinaceous preparations. If the exhaustion is very great, and especially if the patient has been accustomed to alcoholic drinks, they should now be given cautiously, and of such kinds as the patient himself prefers.

If the remission is less complete, *i.e.*, if the heat of skin, agitation, and gastric distress have not completely subsided, the same means as in the first stage should be resorted to for allaying these symptoms. The warm bath, or blankets wrung out of hot water, may be used with precautions against fatigue. Mustard plasters should be applied to the epigastrium and the back of the neck, and cool or iced drinks cautiously administered. The irritability of the stomach may be further allayed by lime water and milk, or by a little spirit of chloroform in some aromatic vehicle, and also by demulcent enemata. If it still continues, and is accompanied with a burning heat in the part, it indicates the presence of an excess of acid in the stomach, and there is an evident propriety in neutralizing it with a little bicarbonate of soda. These means will often suffice for the cure.

But if the skin grows more yellow, the eyes more injected and wild in their expression, the stomach more irritable, and the vomited liquid more acrid, and especially if dark flocculi appear in it, the occurrence of black vomit is imminent. The danger is now extreme, and the means of safety are few and feeble. They consist in the renewed application of mustard to the epigastrium, the repetition of lime water or of soda by the mouth, the injection by the rectum of beef tea and alcohol, if the stomach rejects them, and sometimes the hypodermic use of morphia in very small doses, when the delirium is active and exhausting. The general distress and extreme thirst at this period have occasionally been relieved by the wet blanket. Creosote has sometimes proved effectual in allaying the vomiting.

These remedies are few and too often unavailing, but they are the only ones that can be relied on even to improve the patient's condition and give him a chance for life.

Convalescence requires the most delicate management to recruit the strength with food without irritating the stomach; to repair the damaged blood without obstructing the kidneys and other emunctories; to renew the wasted strength without exhausting the slowly acquired gains; to occupy the mind without harassing or fatiguing it. In these, as in all other things pertaining to the treatment of a disease so rapid in its course and so dangerous to life as yellow fever often is, the value of a true physician is best demonstrated; of one who employs science only to enlighten experience, and whose practice is guided by the case before him more than by any rigid rules suggested by the supposed nature of the disease.

A PECULIAR FORM OF MANIA.

DR. MESCHEDE described, at the meeting of the Naturalists and Physicians at Cassel, a peculiar form of mania which he had observed, and which is the reverse of the mental disease known under the name agoraphobia, in which the patients are suddenly taken with a sensation of terror and giddiness when attempting to cross a large open space or when entering a hall or facing a large multitude. In the disease observed by Dr. Meschede, the patient, a young man aged 20, was subject to oppression and giddiness whenever he entered a small room or a narrow space. He had been obliged to leave his studies and to apprentice himself to a farmer. He could not sleep in a room, but camped out in the fields and woods during summer; and only during the coldest part of winter could he be prevailed upon to sleep in a large and airy apartment with all the windows open. There was no hereditary predisposition, but certain sensorial anomalies existed, and he had also suffered for several years from ear disease. There were no other traces of mental affection. Another similar case was that of a patient suffering from diabetes who experienced much the same sensations. The author thinks that this disease ought to be classed under the same head as agoraphobia, as in both the characteristic symptom is that the patient cannot by any means form an accurate conception of the dimension of his surroundings. He also mentioned a third curious case; that of a man, who, after recovering from poisoning himself with prussic acid, could not remain in the middle of the road when he saw a vehicle approaching him, even at a considerable distance, but was forced, as it were, against his own will, to stand aside without waiting for it to come nearer.—*British Medical Journal.*

CHRONIC ARTICULAR RHEUMATISM AND RHEUMATOID ARTHRITIS.*

CHRONIC articular rheumatism may follow the acute form of the disease if it is not treated promptly and effectually, or it may occur as a distinct disease occurring in damp weather and characterized by stiffness and pain in the joints.

If the disease appears originally in its chronic form the joints do not usually undergo any change, but if the chronic stage follows an acute attack the joints are quite stiff. The pain in these cases often extends to the muscles, fasciæ, and long bones, and in syphilitic rheumatism the bones of the sternum and cranium are affected and covered with nodules. In this condition the moral conduct of the patient is, of course, not involved as in hereditary and acquired syphilis.

To go somewhat more into details the symptoms may be divided into the habitual symptoms and those which arise during the exacerbations. (The chronic form of rheumatism is sometimes called "cold" rheumatism.) In these cases the sensibility to cold and dampness is rendered morbidly acute. When exacerbations occur the disease assumes a subacute type, and all the joints become red, swollen, and warm. The pain is aggravated by heat. These exacerbations are of indefinite duration.

If the joints have not become positively deformed you may be moderately sure of a cure, at least a cure may be hoped for. If a cure is not established the functions of the joints will never be re-established. These deformities of the joints are, in reality, lesions of the soft parts.

The treatment of the febrile, or sub-acute form of chronic articular rheumatism demands the same internal remedies as in the acute form—the local application of heat, the use of the alkalies, moisture, local stimulants, narcotics, and sudorifics. In the chronic form local stimulus and alteratives are especially indicated. Among the best of the local stimulants may be mentioned camphor, turpentine, ammonia, and chloroform, and the more active stimulants, or counter-irritants—iodine, cantharides, mustard, croton oil, moxas, and blisters.

In the treatment of chronic rheumatism of the more superficial joints blisters are the best application; for the deeper joints, such as the hip, I prefer moxas.

In the case of the elbow, knee, and ankle joints a very excellent form of local alterative is sulphur in fine powder laid between the folds of linen and applied to the joints. Other remedies of value for the protection of the part from the air, and the maintenance at the same time of a gentle stimulating action, are the burgundy pitch plaster and the ammoniacal plaster with mercury. Croton oil and tartar emetic are but very rarely used. Where the shoulder is the joint affected a series of local blisters should be employed.

In all cases of rheumatism of the joints passive motions should be practiced to prevent permanent stiffness of the parts, and the induced current of electricity should be frequently passed through the affected parts.

In passing I must not forget to dwell upon the great efficacy of local hot baths. This I consider a most important therapeutical agent in chronic articular rheumatism. These baths may consist of hot or warm water, air, or steam; and in this connection some of the saline, alkaline, or sulphureted mineral waters may be employed. Sulphureted waters are very widely used in this country and in Europe in the treatment of this affection. It is this virtue which has given a reputation to most of the familiar springs on the continent of Europe.

Another curative agent of great usefulness in hot water baths is the diaphoresis set up, and this should be supplemented by horseback riding and by walking. If the reaction which follows it is vigorous, sea-bathing is sometimes excellent. So, too, with regard to the cold, heat and sweating produced by the hydropathic packing.

The principal medicinal agents employed with good effect in chronic articular rhematism are guaiacum, oil of turpentine, iodide of potassium, cod liver oil, alkalies, and sulphur. It was in the treatment of this disease that cod-liver oil first gained its repute as a remedial agent. Guaiacum has been extravagantly lauded by some. The usual forms in which guaiacum is best administered are the tincture and the ammoniated tincture in doses of f. ʒ j.–ij. three times a day, or the mistura guaiaci composita may be given in doses varying from f. ℥ ss.–j. every four hours. The ammoniacal tincture is employed where additional stimulus is needed, and the compound mixture where no stimulation is wanted.

There is a prescription used in England which has a great reputation in this disease, and which I really think does great good, viz., the so-called "Chelsea Pensioner," from the fact of its first being used among the rheumatic old pensioners in the Chelsea Home.

Its ingredients are the following:

℞. Of the flowers of sulphur............two ounces.
" cream a tartar............................one ounce.
" powdered rhubarb ....two drachms.
" Guaiacum (resin)........................one drachm.
" Clarified honey ....one pound.
" powdered nutmeg.......................two drachms.

M. S. Take two large teaspoonfuls at night and morning for three days, in honey or mulled wine.

Of other medicines the oil of turpentine may be given in doses varying from f. ʒ ss.—f. ʒ j. thrice daily. Mention may also be made of the balsam of copaiba and the oil of cajeput. The latter in particular is said to be of great service by some.

Where the fibrous investments of the joints are swollen, the iodide of potassium is a very valuable remedy. In those cases which are of syphilitic taint, in addition to the iodide of potassium, mercury is very valuable, but it should only be pushed to a slight extent. The best form of mercury is the bichloride, and it is best administered in the compound syrup of sarsaparilla. This mixture is most efficacious. All general systemic disorders should at the same time be sedulously treated with iron, quinia, and other general tonics. If there is any biliousness, purges should be judiciously administered.

In conclusion, I may say that if all the forms of treatment which I have mentioned prove of no avail and if the patient can afford it, he or she should at once be sent to some tropical climate to spend the winter.

* A lecture delivered before the Medical Class of the University of Pennsylvania. By Alfred Stillé, M.D., LL D., Professor of the Theory and Practice of Medicine and of Clinical Medicine. Reported for the *Hospital Gazette.*

RHEUMATOID ARTHRITIS.

This condition is very apt to be confounded with chronic articular rheumatism, although in reality the analogy between the two diseases is but slight. Change of structure in the joints themselves is the essential symptom of rheumatoid arthritis, whereas in chronic articular rheumatism the structural changes do not take place in the joints, but in the ligaments which surround the joints. Rheumatoid arthritis is sometimes called rheumatic gout, but it bears hardly a single resemblance to gout. Unlike both articular rheumatism and gout, it begins very slowly, invading one or more of the joints, a long time elapsing before all of the joints of the body are involved.

Rheumatoid arthritis may begin at any age, but is especially frequent in childhood, and attacks women more frequently than men. I have seen an unusual number of cases of this disease, and they have all occurred in women. The disease is not confined to any particular class of society. It begins in childhood, perhaps, and runs on unchecked until the extreme limit of old age. In some cases, indeed, although its presence becomes a perpetual source of agony, it yet seems to be conservative of life, patients with rheumatoid arthritis often living to a greater age than those upon whom the disease has not laid its enduring grasp.

In the first stage of the affection one or more of the joints are swollen. In time the affected joints become enlarged and deformed by a *bony swelling external to the joint itself.* Passive motion of the affected joint is attended with pain and a crackling sensation. If the disease continues, the joints may in time become disarticulated. After death the joint is found to be the seat of the synovial effusion, with vascular injection early in the progress of the disease, while later the fluid is absorbed and the cartilages ulcerate and are sometimes even altogether removed, the denuded ends of the bones undergoing conversion into an ivory-like substance which is hard and brittle. As the ligaments of the joints undergo atrophy or relaxation, the opposite faces of the bones are subluxated, or soldered together.

Rheumatoid arthritis may be distinguished from acute articular rheumatism by the following points. In the acute stage of rheumatoid arthritis there are none of the febrile symptoms of acute rheumatism, nor do the joints become red, nor is the urine acid, nor do heart complications exist later on in the disease. Rheumatoid arthritis is localized in the joints themselves, and chronic articular rheumatism in the ligaments and tendons.

Rheumatoid arthritis may be distinguished from gout by the absence of dusky veins and œdematous swelling. Also by the absence of the gouty urine and of the chronic valvular disease of the heart. In gout the deformity of the joint is caused by the fact that the joint is enveloped in a mass of the urate of sodium, constituting what is known as "gout stones."

The prognosis in rheumatoid arthritis is that the disease is never fatal, but that it causes a great deal of suffering; that the limbs are twisted into almost impossible positions. In one case which I saw, rotation of the head and deflection of one finger were all the movements that could be made. In that case the disease followed membranous colitis produced by sleeping between damp sheets at the sea shore.

The treatment of the disease consists in rest and all the possible hygienic comforts; good food, fresh air, plenty of sunshine, and ample clothing. Among drugs, the best are cod-liver oil with arsenic. The arsenic is best administered in the form of the arseniate of potassium in the large doses of from ten to fifteen minims three times a day. The cod-liver oil must be continued as long as the stomach can bear it, suspending it from time to time as the stomach begins to rebel.

If given early, these remedies are said by some to have arrested the disease; but I must confess, for my part, that I have never seen the slightest benefit follow their employment. The pain in the joints should of course be eased, if possible, by anodyne applications. In some cases good seems to follow the painting of the affected parts with a very strong tincture of iodine.

DYSPEPSIA

ON this subject Dr. A. Leared says, in the *British Medical Journal:*

In the treatment of all forms of dyspepsia attention to diet claims a prominent place. Articles known to be slow of digestion must be avoided, and a lessened amount of food must be taken only at proper times. But, as a rule, absolute strictness in diet is more necessary in dyspepsia from defective secretion than in that from impaired motion; for, as already said, in the latter affection digestion is sluggish rather than imperfect. One dietetic rule is, however, of the greatest importance in the present case. The principal meal should be taken early in the day, before the nervous system has been exhausted either by mental or by bodily exertion. In some instances the power of digestion seems to diminish in proportion as the day advances. A distinguished literary lady consulted me, who had, by incessant brain work, fallen into a state of great suffering from gastric oppression and flatulence after meals. At my suggestion she dined early instead of late in the day. This change was beneficial, but was not effectual in affording relief. I then advised that she should eat meat at breakfast only, and that no writing should be done before the meal. This plan succeeded perfectly.

From its well known power in causing muscular contraction, strychnia suggests itself as the remedy for impaired gastric peristalsis. It affords the most powerful means we possess of restoring the gastric functions. I may, perhaps, take some credit for having helped to make known its value. So long ago as 1860, I wrote: "Speaking from extensive experience, I know no single medicine of more value. . . . It acts by increasing the tone of the muscular coats of the stomach and intestines. When these coats are relaxed, gases are generated, mainly owing to retardation of the aliment in the cavities. No remedy has in my hands proved so permanently effective as strychnia against this inconvenience." ("Imperfect Digestion," 1st ed., p. 186.) In 1864 the late Dr. Brinton, following Chomel, condemned the use of strychnia in stomach diseases as unnecessary and dangerous. ("Diseases of the Stomach," p. 334.) But, notwithstanding the condemnation of these authorities, strychnia has held its place in these affections, because, although too often given without discrimination, it proves beneficial in many instances. The secret of its successful administration lies in the recognition of the cases. It is suited for cases characterized by the symptoms of impaired motion; namely, uneasiness, but not actual pain, after food, and flatulence. It is not suited for cases of impaired secretion, characterized by pain after food and little or no flatulency.

Some precautions are, of course, necessary, and more so because the patients are seldom under daily observation. A dose of one-twentieth of a grain should rarely be exceeded. It should never be given in pills, on account of the difficulty of exact subdivision in that form. The susceptibility of the alkaloid to precipitation by alkalies and some other substances must be kept in view. If so precipitated, the whole of the drug would, of course, be contained in the last dose in the bottle. For the rest, the pharmaceutist must be responsible. But, after having prescribed strychnia some thousand times, I never knew any harm to arise from its use.

It might be supposed that electricity would prove useful for lesions of peristalsis; but after many trials of faradization and a few of the direct current, I am compelled to say that I do not regard it as a useful agent in this affection.

It is sometimes desirable to check flatulence by some agent which hinders fermentation. Formerly, I prescribed carbolic acid for this purpose; but its unpleasant taste is a great drawback. Of late, I have used thymol with, I think, better results; and the taste is far less objectionable.

Many cases are met with in which the stomach is unable to expel flatus in consequence of temporary paralysis from over-distention. Various drugs given to promote contraction of the organ—carminatives, as they are called—sometimes fail in their purpose. It is in such cases that charcoal proves useful. Charcoal possesses a remarkable power of absorbing gases; but this power, as I have elsewhere shown, is very much lessened by long keeping and by wetting. This led me to the plan of giving, in hermetically sealed gelatine capsules, charcoal prepared from vegetable ivory, which kind was proved by experiment to possess the best absorbing power.

If, in cases of obstinate gastric distention, three or four such charcoal capsules be swallowed, a few cubic inches of carbonic acid gas will be speedily absorbed. Tension being now removed, the muscular coat of the stomach generally resumes its power, and flatus is freely expelled. In a few obstinate cases, however, chiefly when the stomach affection is secondary to diseases of the liver or kidneys, the muscular paralysis is so complete that, as happens in case of the over-distended *rumen* in cud-chewing animals, mechanical interference is the most effective mode of treatment. For this purpose, I have had made a small India rubber tube two feet in length, having one extremity closed, and perforated like a drainage tube to the distance of four inches from the end. Such a tube can be safely and easily introduced into the stomach, and will prove effectual in relieving the distended organ.

BLISTERING.

DR. H. S. ANDERSON, in his Harveian Discourse, published in the Edinburgh *Medical Journal*, says:

A remedy which I fear is somewhat unduly neglected nowadays is counter-irritation by means of blistering; and I think I have observed in some young practitioners an approach to something like terror when blistering is spoken of as a remedy that may frequently be used. Certainly, as regards children's diseases, there is more of this fear than there should be. It has frequently, for example, been my experience so see children, in consultation with a younger practitioner, when blistering in acute head affection had never been dreamed of. In mostly all acute inflammatory affections of the brain, tubercular or not, in children, I am strongly of opinion that after shaving the head the application of blistering fluid has a most rapid and satisfactory effect.

Inflammatory attacks also, of the peritoneum and chest, in children, are often controlled by blistering, although the size of the vesicatory and the length of time applied must be carefully considered. And in the rheumatic affections of the joints, in adults, repeated blistering has often the happiest results. For many chronic conditions also, counter irritation has always held a high place in my list of remedies. In chronic tubercular affections of both chest and abdomen, I think occasional and repeated blistering is frequently beneficial, and also in chronic and obscure head and other affections of the nervous system. For example, a blister over the roots of the nerves, in herpes zoster, often relieves the neuralgic pain so generally present, and often so difficult to get rid of. In diphtheritic paralysis, also, blistering the nape of the neck, and even down the spine, often expedites cure in a wonderful way. In the uterine or ovarian pain so often complained of in the left side, there is no better remedy sometimes than a succession of fly blisters, and the tenderness of spinal irritation is very frequently relieved, if not got rid of, by the same means. In chronic effusions the use of blisters is still fully acknowledged, and does not therefore call for special mention.

CHOLERA INFANTUM.

THE following treatment is recommended by Dr. W. Frank Hines, of Maryland, in the *Southern Clinic:*

Nothing is of more importance in this trouble than the diet. The practice of giving farinaceous substances—cracked wheat, tapioca, farina, etc.—is surely wrong and hurtful.

The digestive organs of the child are very weak, and to put anything in them which they have not been in the habit of receiving is to overtax them; milk contains all the necessary ingredients for the support of the infant; but it does not contain any starch. If possible, the child should be fed on "mother's milk." If this is not practicable, cow's milk may be made to answer. Condensed milk I have seen act in a very satisfactory manner, when there is great prostration and weakness. Beef tea, with a little brandy in it, is very beneficial; say a teaspoonful of beef tea with half a teaspoonful of brandy, every three hours.

In regard to medication, I do not think a great deal is needed, except when there are frequent discharges. They must be stopped; if not, the child will die from weakness. In this connection the following treatment has been of great service:

℞. Bismuth. subnit .... ʒ ss.
Spts. ammon. arom .... ʒ ij.
Tinct. opii camph .... ʒ iss.
Syrup. simplic.,
Aquæ fon.............................. aa ʒ ss. M.

Sig.—Teaspoonful every 2½ hours to child 1½ to 2 years old, according to condition.

In some cases, where the diarrhea is of a very persistent character, stronger measures will have to be resorted to; these are best determined by the circumstances of the particular case. The temperature should be kept down; there is nothing better for this purpose than quinia; but as tuere is generally head trouble in these cases, I do not think it advisable to use it. Cold cloths applied to the head, sponging with cold water, and ice water cloths to the abdomen, will lower and keep down temperature very satisfactorily, besides often relieving the head trouble.

THE IDENTITY OF TUBERCULOUS CORPUSCLES AND DECOLORIZED BLOOD CORPUSCLES.

To the Editor of the Scientific American:

To show that the blood corpuscles left in excess in the blood vessels, by a loss of albumen therefrom, are the source of tubercles, and organized into them, as claimed in my last, I send you the following proof of the identity of tuberculous corpuscles and decolorized blood corpuscles.

Tuberculous matter, at the earliest period it has ever been recognized as such, consists of spherical cells, or corpuscles, which are transparent and identical in appearance in this and every other respect with decolorized blood corpuscles immediately after the latter have been distended from their natural disk shape to the globular form, and had their hæmatin, or coloring matter, washed out of them—changes that are invariably and quite rapidly wrought in the red blood corpuscles whenever they are drawn and immersed in pure water, or when they have to circulate in a serum which has been thinned or made much too watery by a loss of a portion of its albumen.

Tuberculous corpuscles are also in that stage inclosed in little protuberant sacs, the walls of which are of the most delicate and transparent structure. These sacs, too, are identical in appearance with the walls of the capillary blood vessels when congested, and distended precisely as the latter are always distended under congestion. And furthermore, said sacs filled with tuberculous corpuscles lie packed together in great numbers, or embedded in a mass, in the lungs or other tissues where found precisely as would be the capillary blood vessels of the same parts, congested with decolorized blood corpuscles. Nor is this all. Organs or parts which have the greatest number of capillaries within a given space are the most frequently destroyed by tubercles of any, as we shall soon see; while in other parts where there are no capillaries, tubercles have never been found.

Again, when either of these so called two sets of corpuscles yields the water that distends them and makes them transparent, they both shrivel alike, and both become yellowish white or identical in color with each other, and from that on to their complete destruction, whether through the more common process of suppuration or the less common process of absorption, every step with each is marked by precisely the same changes and appearances as the corresponding stage of the other. For instance, both shrivel into the same or very similar forms, as angular, elongated, jagged, etc., or as Rokitansky says of tuberculous corpuscles, "anomalously shaped, irregular, as if gnawed, angular, bent, constricted, rudimentary, stunted." Both also become alike granular as they shrivel; that is to say, appear to consist of nothing but a mass of granules, to the number of ten to twenty or more in each, and these granules appear identical in the two kinds of corpuscles, under all their varying conditions.

The corpuscles, moreover, fall to pieces into these granules, and in the same way under decomposition; they are alike in size one with the other in the corresponding stage of all the changes they undergo, and they are the only two kinds of cells in all cell structures that are alike in any of these respects. But the crowning proof of all is the following:

A blood corpuscle has no nucleus. A tuberculous corpuscle has no nucleus. And yet among the great variety of cells found in all animal life, whether in natural or in morbid growths, blood corpuscles and tuberculous corpuscles are the only two kinds of cells without a nucleus. What can all this mean, then, but that the two are the same? No two different things, or rather different species, are anywhere found, either in organic or inorganic nature, with such similarities as these.

But complete as the foregoing proof is as to what tuberculous corpuscles are, it is by no means all there is to show us that they must be decolorized blood corpuscles. Nature does not allow of the possibility of a doubt in such an important matter as this, when we fully comprehend her action and methods. To show this we have one of the most beautiful of all indirect or negative proofs to be found in the whole range of organic creation, standing out so clearly that it may even be said to be strongly positive in the following:

Tubercles have never been found in cartilages (Rokitansky).

And there are no blood vessels, capillary or otherwise, in cartilages to carry blood corpuscles into them to make tubercles. But tubercles are found in every tissue that blood vessels enter, and much the most frequently in parts where the capillaries are the most numerous, as in the apex of the lungs. Less and less frequently as we descend in the scale of parts and tissues where the capillaries are sparser, until we come to the bones, which have the widest meshes between the vessels, and are the least frequently destroyed by tubercles of any vascular tissue; and lastly come the cartilages which are without blood vessels, and never injured by tubercles.

The nutrition of cartilages is carried on in the following manner:

They are channeled or penetrated in every direction by little canals (canaliculi) very much less in size than the diameter of the smallest blood corpuscles; which canals open upon the surfaces of the cartilages and into the sheaths of capillary blood vessels running along or lying in contact with every part of those surfaces. These canals are large enough to and do admit the serum of the blood, and everything in solution therein, and it is in this way that they receive their nutrition, but as just said, they are much too small to allow the possibility of blood corpuscles ever entering them, even could the latter escape through the walls of the capillary vessels, which they never do unless said walls are broken by disease or injury.

Were the matter of tubercle, therefore, caused by defects of digestion, and carried to all parts in solution in the serum, as has long been taught, some of it must necessarily be carried into the cartilages as well as into other tissues, to be deposited to cause tubercles in them, but such a thing has never yet been known. Hence we must look to that element or portion of the blood that never does and never can, under any circumstances, enter the cartilages, to find the cause or source of tubercles; and as that element of the blood is the blood corpuscles, and those alone, we cannot go beyond or outside of them for a solution of this most important of all questions in disease.

And as the frequency with which organs or parts are destroyed by tubercles is in the exact ratio, or approaching that pretty closely, of the vascularity of a part, or of the number of capillaries within a given space in an organ, there would seem to be little ground for question as to what all this must mean

In conclusion, is not the foregoing proof carried so far beyond the utmost limits of doubt, that all must concede that this greatest of all the mysteries of medicine is thus shown to be one of the simplest of all the developments in nature; and if so, may we not hope that the entire medical profession will now join hands in one continuous, harmonious, and earnest struggle to rid our race now and for ever of so terrible a scourge? All that is needed to do this is to give our undivided attention to the proper measures for healing the mucous membranes in all cases, and stop the further waste of albumen, which is the cause of all. And that this may be done in the first stage, we have the proof in a reliable series of physiological facts, which show beyond all question that of all tissues the mucous membranes are the most readily and easily healed of any by judicious treatment.

ROLLIN R. GREGG, M.D.

Buffalo, N. Y., July 16th, 1879.

THE TREATMENT OF HEMORRHOIDS BY INJECTION.

PROF. EDMUND ANDREWS, of Chicago, has recently investigated this subject with much care and labor. This plan of treating piles has been practiced extensively of late by itinerant quacks throughout the West. Professor Andrews has corresponded with these people, as well as with regular surgeons. Carbolic acid is the medicament chiefly used, the strength of the injection varying among operators from pure acid to one part to twenty of some incipient, as olive oil, glycerine, etc. Ergot is sometimes added. Creosote and persulphate of iron are used by a few. Professor Andrews has procured the history of thirty-two hundred and ninety-five cases, operated on by all sorts of people. Nine are said to have died from the effects of the operation; of these only four can, he thinks, be justly charged to the treatment. There were five cases of dangerous hemorrhage, five of less danger; ten had abscesses; twenty-three had sloughing, mostly of the piles only; eight had suspected embolism of the liver; one abscess of the liver; two had stricture of the rectum; two had severe inflammation; seventy-seven had violent pains, lasting often for days; six were dangerously sick in bed from two to six months; one had permanent impotence; in one an injection caused dangerous carbolic acid poisoning; there were seven relapses, and eight failures to cure. Of the cases of death, one had large abscess, fever, and pyæmia, and died on the fifth day; the patient previously had good health. One had apparent embolism of the liver, torpid bowels, jaundice, large inguinal and axillary glands, and death occurred ninety days after the operation. One patient was a man of eighty-four years; the injection was made into the prostate glands, and death took place in three days. A fourth case had a similar accident and result as the last. One case of great suffering was where the plan was pursued of tearing open the hemorrhoidal veins with a bunch of needles. Great bleeding took place, intense suffering, and the family doctor was consulted. He found the quack had plugged up the opening made by his needles with a small cork. The operation of injection of piles is not painless—only one patient in four so saying. Andrews thinks the operation is not as safe as that of the ligature. Of three thousand cases, one in sixteen is known to have suffered some disaster, from severe pain to death. He thinks large injections are more likely to produce embolism, abscess, and sloughing, than small ones. There is no evidence that embolism of any other organ than the liver has occurred. Strong injections are open to the same objections as large ones, except that they are less likely to produce embolism. Pain depends on the situation of the pile; most pain occurs if it is near the verge of the anus.

The conclusions are that the operation is a proper one for selected cases. The best agent is carbolic acid and oil or glycerine, one part to ten, twenty, or thirty. If glycerine is used, morphine, chloral, or iodoform may be added for an anodyne. The proper quantity to inject at one time is two to four drops, and the operation may be repeated every four to ten days. The surface should be protected with a smearing of oil or vaseline, and the hypodermic needle should be kept in place some minutes after the injection to prevent return of the fluid upon the surface. A very sharp needle should be used, and the injection made slowly. The treatment should be used for internal piles only, and but one pile at a time should be attacked. The patient should be kept in bed eight to ten hours after each injection to avoid hemorrhage. The rectum may be tamponned firmly above the pile to prevent hepatic embolism, the tampon being kept in place twenty-four hours after the operation, but this procedure is hardly necessary unless the stronger injections are employed. Finally, he considers the operation not as safe or eligible as the ligature, but when performed with care as good as any other operation except the ligature.—*Boston Med. Jour.*

CITRINE OINTMENT.

By J. U. LLOYD.

THIS ointment has been so often written upon, and so many processes for its preparation have been suggested, that it seems as though little could be said upon the subject that can be of advantage.

The process of the Pharmacopœia preceding the last edition, in which twelve troy ounces of neat's-foot oil and four troy ounces of lard are employed, certainly was not in good proportion, as the experience of many has shown. Upon the other hand, it may be that we have gone into extremes, in doing away altogether with the oil, and, perhaps, others (than myself) may find that an ointment made with lard alone will eventually become hard and dry.

The following is the proportion of neat's-foot oil and lard that I have used for some years:

Lard, three parts.
Neat's-foot oil, one part.

It will be seen that the proportions of the former Pharmacopœia are reversed, and with care in other particulars, the ointment obtained will be without objection.

When mercury is dissolved in nitric acid U. S. P., the product is likely to be a mixture of mercurous and mercuric nitrates, the proportions varying with temperature at which the reaction takes place, etc. If mercuric oxide only be used and dissolved in excess of nitric acid, mercuric nitrate is formed.

One and one-half troy ounces of mercury is equivalent to 777¾ grs. of mercuric oxide; therefore, one troy ounce and

five drachms will about equal the mercury of the present officinal process.

Thus modified, the formula will read as follows:

Take of

Red oxide of mercury	780	grs.
Nitric acid	3¼	oz.
Neat's foot oil	4	oz.
Lard	12	oz.

Dissolve the red oxide of mercury in the nitric acid. Place the lard and oil together into an evaporating basin of twelve to sixteen pints capacity, and raise the temperature to 180° F., remove the heat and add the solution of nitrate of mercury with constant stirring, using a wooden, glass, or porcelain spatula. Chemical action will at once ensue, and the temperature will rise to about 220° F., over which it should not be allowed to pass. It may be regulated by means of the solution. When effervescence ceases, and the ointment has cooled to 180° F., strain through a thin muslin strainer. It is necessary that the acid be of full strength.

It will be perceived that whatever advantage the foregoing may have over the present officinal formula, this must result from the fact that the salt employed is always mercuric, and that the addition of the oil may produce an ointment of better consistence.

This ointment can be prepared in a very short time.

In case the present officinal process is satisfactory to all concerned it will not be advisible to change the formula.—*New Remedies.*

SUBERINE FOR CHAPPED NIPPLES.

THE treatment recommended by M. Brochard, *L'Union Médicale du Canada* (*Chicago Medical Journal*), for fissured nipples is so simple that it deserves to be popularized. When chaps exist on the nipples, whatever their extent, the nipple should be washed with pure water, and then dried and dusted with suberine, which, as is known, is impalpable cork powder. The author has used it for several years, and prefers it to lycopodium for infants, because it contains tannin, and besides is much cheaper. Over the suberine is placed a piece of gold-beater's skin, cut star-shaped, in the center of which several punctures are made with a fine needle. Every time the child is suckled, the suberine is washed off with water, and the gold-beater's skin replaced, the child drawing the milk through it without giving pain. When the child is done, the suberine is again applied as before, and so on.

TURPENTINE IN WHOOPING COUGH.

GERTH cured a case of laryngeal catarrh by placing twenty drops of turpentine on a handkerchief, held before the face and causing about forty deep inspirations to be taken. Repeating this thrice daily, the cure was quite rapid. In the same family he found an infant fifteen months old in the convulsive stage of whooping cough, quite exhausted, and vomiting all ingesta. There was at the same time slight bronchial catarrh with slight evening rise of temperature. Gerth decided to experiment here also with turpentine. He directed the mother to hold the moistened cloth as above, before it when awake, and to drop the oil upon its pillow when asleep. The result was most happy. Within the twenty-four hours the frequency and severity of the attacks notably diminished. The child's strength was sustained by stimulants, and improvement was very rapid. Within a year pertussis became epidemic in his vicinity, and he repeatedly tested the drug in this way. He gave it to children of all ages, and in any stage of fever. The initial catarrh, the convulsive, and the final catarrhal stages were all decidedly benefited, the spasmodic attacks being in many cases aborted.—*Chicago Med. and Sur. Journal.*

A NEW ANÆSTHETIC.

THE Paris correspondent of the *Lancet* gives some particulars of Professor Bert's new method of producing anæsthesia. A mixture of eighty-five parts of nitrous oxide and fifteen parts of oxygen was inhaled by a patient under increased atmospheric pressure. The experimenters were subject to the same pressure, but it was not sufficient to cause serious discomfort. In about fifteen seconds the patient was completely insensible and the muscles relaxed. Dr. Labbé then operated for ingrowing toe nail, and the patient recovered consciousness in less than a minute after the anæsthetic was withdrawn. Under ordinary pressure the mixture does not produce any anæsthetic effect.

TARTRATE OF MORPHIA.

DR. JOHN E. STEWART, in the *Edinburgh Medical Journal* for March, advises the use of tartrate of morphia as the best preparation of the alkaloid for hypodermic injection. It is a white powder, not unlike the hydrochlorate of morphia, forming a milky solution in cold water, but a clear one in hot water, in the proportion of forty grains to the fluid ounce. It is claimed that the solution is perfectly unirritating, does not need filtering or neutralizing, and keeps fresh and unchanged for any length of time. It is recommended also for administration by the mouth.

NERVE STRETCHING IN TETANUS.

DR. THOMAS, of Tours, reports a case in which the symptoms of tetanus were relieved immediately by nerve stretching, although the patient died a few hours afterward. The patient, a man 28 years old, wounded the ball of his left thumb deeply by a fall upon broken glass. The wound did well, and the patient returned to work. Three weeks after the accident cramps were felt in the wounded hand and corresponding arm; the next day the cramps were more severe; the third day the jaws became stiff, and on the fifth day he entered the hospital in the following condition: Marked opisthotonus, with such rigidity that the patient could be raised by the neck or heels; impossibility of separating the jaws for a greater distance than half a centimeter between the incisors; difficulty in swallowing; every four or five minutes very painful convulsions, excited by the least effort or the lightest touch of the wound. The slighter spasms involved only the injured hand and corresponding arm; the more severe ones involved both arms, and the opisthotonus and trismus were increased during the attack; profuse perspiration, dry tongue, pulse 120, temperature 39°. On the left thenar eminence was a wound three or four centimeters long, filled with healthy granulations, but not suppurating. Intelligence was complete, and the patient declared that no foreign body remained in the wound, which at the time of the accident was large and gaping; he also said that he had not been exposed to cold, and that he was not intemperate. The treatment ordered was hypodermic injections of morphine in the neighborhood of the wound every four or five hours, and a potion containing eight grammes of chloral hydrate, to be taken in the course of the twenty-four hours.

The next (6th) day the patient being no better, pulse 120, temperature 40°, elongation of the median nerve was determined upon, and practiced in the lower third of the arm, with the aid of Esmarch's band and local anæsthesia; the nerve was exposed for a distance of three centimeters, raised upon a grooved director and twice compressed firmly against it.

Several spasms occurred during the operation, and two slight ones followed it. An hour later the patient fell asleep, and rested quietly for two hours. On waking he had a very slight spasm, the last, moved his legs easily, drank without difficulty, and said he felt very well. At 5 P.M. the pulse was 140, and very small; temperature in the axilla 41°. At 7 P.M. delirium, 10 o'clock coma; 11 o'clock death.

The autopsy showed that there was no foreign body in the wound, and that the internal collateral nerve of the thumb, which was in contact with the deeper part of the wound, was indurated, yellowish, and adherent to the cicatrix. The median nerve, which was normal in the forearm, was deeply congested, flattened, and soft with rupture of the peripheral and conservation of the central fibers, at the point where it had been stretched.

The lower lobes of the lungs were intensely congested; the liver showed in its convex surface pale, anæmic spots, due to the crowding of the capillaries with leucocytes. No pus in the joints or axillary glands, but three small subcutaneous abscesses in the left forearm. In the title of the note the death is attributed to purulent infection or pyæmia, but neither the autopsy nor the clinical history seems to warrant this view. Possibly if the operation had been performed two or three days earlier the result might have been different.—*Bulletin de la Société de Chirurgie, Archives of Medicine.*

[Continued from SUPPLEMENT No. 189.]

[Translated from La Nature.]

THE BEGINNINGS OF LIFE.—III.

By PROF. EDMOND PERRIER.

BEINGS INTERMEDIATE BETWEEN ANIMALS AND PLANTS.

THESE beings really exist, and are by no means those that are often designated as plant-animals or zoophytes. The latter are true animals, notwithstanding the quite striking resemblance that their ramified colonies present to the branches of a shrub. But there are a number of organisms lower than them, and in regard to the nature of which the ablest naturalist would be embarrassed to pronounce. Haeckel got over the difficulty by creating a special kingdom for these ambiguous beings, and to which he gave the name of protista. Among these protista must be arranged all those beings which we have hitherto considered. At first sight this is a very astonishing proposition. How are we to believe that beings which move and devour living prey can have anything in common with plants? Are not these two faculties in the highest degree characteristic of animals? and do they not form an absolute contrast between the latter and plants which are immovable and incapable of feeding in any other way than by the aid of liquid or gaseous matters? It has, indeed, been thought so for a long time; but a more exact study of plants shows that these differences are far from being as absolute as they seem. In the first place, movement is in no wise the exclusive property of animals. Without speaking of the movements of sensitive plants, of the leaves of dionæa and utricularia, of the hairs of drosera, and of many others, the causes of which appear to be peculiar to the vegetable kingdom, it is easy to recognize, even in the higher plants, movements that are essentially identical with those that are observed in the other kingdom. Plants, like animals, are composed of cells. The young plant cells always contain a substance identical in all characters with the protoplasm of which we have before spoken. In the hairs of the tradescantia virginica, in the poisonous hairs of the nettles, in the stellate hairs of althæa rosea, in the cells of chara, etc., this protoplasm is the seat of a true protoplasmic circulation analogous to that exhibited by sarcode in the monera and rhizopods. It seems that we have only to break the cell wall in order to see the protoplasm spread out *en masse*, and move in the manner of amœbæ. In drosera, Darwin has minutely described very curious protoplasmic modifications which accompany the movement of its hairs.

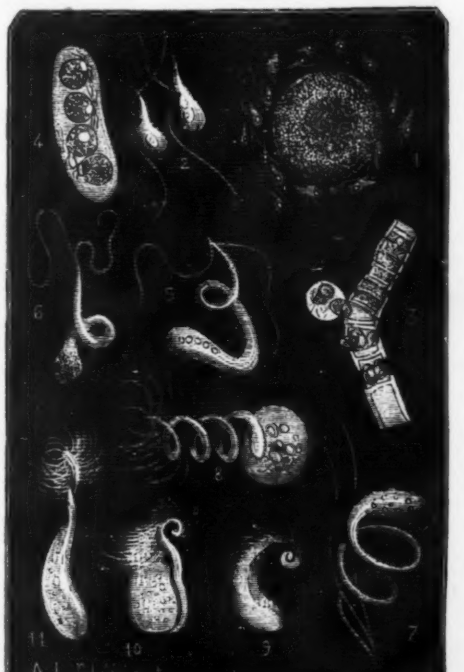

FIG. 1.—ZOOSPORES AND ANTHEROZOIDS OF CRYPTOGAMS.

1. Spore and Antherozoids of *Fucus vesiculosus*. 2. Antherozoids of the same more highly magnified. 3. Antherozoids of *Œdogonium gemelliparum* issuing from the filament in which they were developed. 4. Zoospores of *Bulbochæte intermedia*. 5. Antherozoid of a chara (*Nitella flexilis*). 6. Antherozoid of a moss (*Funaria hygrometrica*). 7. Antherozoid of another moss (*Sphagnum*). 8. Antherozoid of a fern (*Adianthum*). 9, 10, 11. Antherozoids of a horse-tail (*Equisetum arvense*).

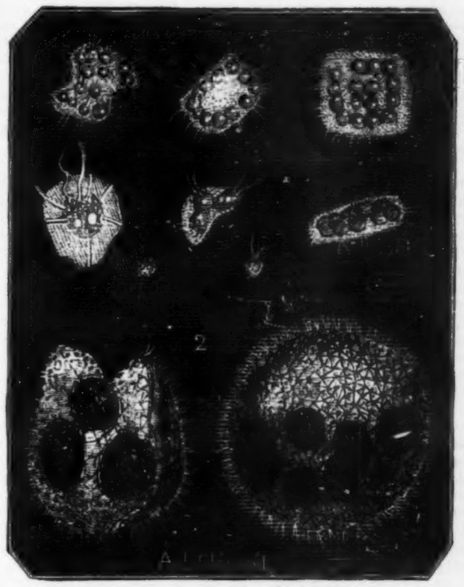

FIG. 2.—ALGÆ OF THE FAMILY VOLVOCINEÆ.

1. Families and isolated cells of *Gonium pectorale*. 2. Families or colonies of *Volvox globator*. (The colony to the left is broken. Both contain young ones.)

But this is not all. When we come to the branch of cryptogams which contains the higher forms, like ferns, we see the faculty of movement generalized. All these cryptogams exhibit a sexual mode of generation, resulting from the fusion of a female element—the spore—with a male element—the antherozoid. The latter is almost always a minute being endowed with extremely rapid movements, which it executes by means of cilia with which it is provided, and which are in all respects like the cilia of the zoospores of radiolarians. In ferns and horse-tails (*equisetum*), the antherozoid, wound like a cork-screw, is provided at its anterior part with quite a number of long vibratile cilia. (Fig. 1, 8.) The mosses and charæ also have antherozoids rolled like a helix, but provided with two cilia only. (Fig. 1, 5.) Fucus and other olive-green marine algæ all possess very active antherozoids, ovoid in shape, sometimes exhibiting an ocular point of a red color, and always two vibratile lashes starting from the same point and directed one before and the other behind. (Fig. 1, 1.) Finally, certain confervæ (a fresh-water algæ) also have antherozoids, the form of which is very variable. Moreover, in this group, and in that of the fungi, another mode of reproduction makes its appearance. The contents of certain cells become changed into small bodies sometimes furnished with one or two vibratile cilia, and sometimes (as in œdogonium) with a crown of cilia. These bodies, which may be called zoospores, after swimming about for some time become stationary and

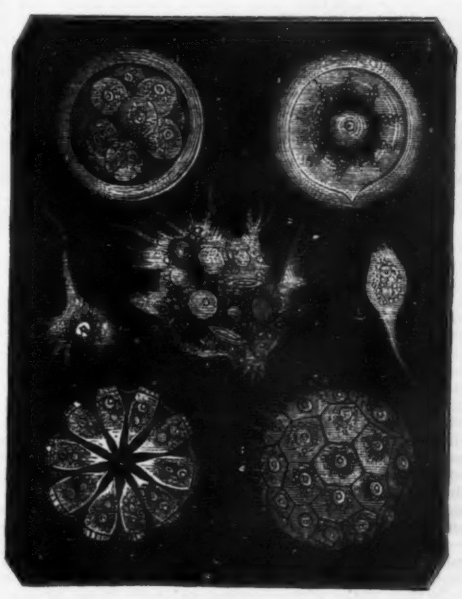

FIG. 3.—MAGOSPHÆRA PLANULA.

1. Ovulary phase of *Magosphæra*. 2. Segmentation of the egg in the interior of the cyst. 3. Adult *Magosphæra*, the surface of which is in the focus of the microscope. 4. The same, showing the internal arrangement of the cells. 5, 6, 7. Cells of *Magosphæra* after their isolation assuming different amœboid forms before becoming encysted to pass to the egg state.

change directly either into an alga or a fungus like their parent. The most common form of the zoospore is that of a small ovoid mass furnished with two cilia. We find here again very nearly the same reproductive element that we have already had occasion to point out in the moners and radiolarians. We cannot doubt, however, that in the present case the organisms that produced it are really plants. The zoospores of algæ are, it is true, generally colored green by that same matter which colors the leaves of vegetables, that is, chlorophyl; but the zoospores of fungi are absolutely colorless, and nothing would indicate, were we ignorant of their origin, that they ought to be referred to the vegetable kingdom rather than to the animal. Chlorophyl is not absolutely confined to plants; for certain infusoria that no one would think of making anything else than animals—stentors, for example—are impregnated with this substance, and, according to recent experiments, are able to give out oxygen in the sun just as plants do. Analogous facts have been observed in worms that are relatively of high organization. This, then, is another distinctive feature of the two kingdoms which disappears.

In the plants of which we have just spoken the period of mobility is relatively of short duration; but it is not always thus. In certain groups its duration is longer, on the contrary, than that of the other periods, so that it constitutes the normal state; the period of immobility being then only a transitory one. We see this, for instance, in the volvoces, stephanosphæræ, and gonia.

A gelatinous mass, spherical in stephanosphæra and volvox (Fig. 2, No. 2), and quadrangular in gonium (Fig. 2, No. 1), contains green cells regularly disposed a little beneath its surface, and each furnished with two vibratile cilia, which project from the gelatinous mass and continuously lash the surrounding liquid. By the movement of the cilia the entire mass swims, turning about as it does so. In volvox (Fig. 2, No. 2) the ciliated cells are very numerous, and are connected together by a sort of network of protoplasm. In stephanosphæra pluviatilis the ciliated cells are only eight in number, and placed perpendicularly to one of the equatorial planes of the sphere. These cells are fusiform, and from their extremities start out protoplasmic filaments which are attached to the periphery of the sphere. It has been found possible to follow almost all of the life phases of this singular plant. During the night each of the eight component cells divides into two, four, and finally into eight new ones, so as to form a little family in all respects like the one of which it formed a part. In the morning each stephanosphæra contains then, instead of eight cells, eight young individuals, which move about in the interior of the primitive gelatinous mass until the latter dissolves and sets them free. The phenomenon is renewed as long as the conditions of heat, light, and moisture last that are necessary to the life of the plant.

From time to time the succession of generations is interrupted by the formation of quite a number of small spherules called microgonidia, and which are the result of a repeated division of the mother cells. These microgonidia, each furnished with four vibratile cilia, separate from each other and swim about freely in the surrounding liquid. Their ultimate destiny is unknown. When the conditions become less favorable, each of the eight cells composing a stephanosphæra loses its cilia, isolates itself, becomes enveloped in a firm membrane, and sinks to the bottom, where its color gradually changes to brown and red. In this state it will very readily stand desiccation, but with a return of moisture each cell divides anew into two, four, and sometimes eight parts, and its enveloping membrane disappears, setting free zoospores, which are provided with two locomotor cilia. Each of these zoospores produces by division a new eight-celled stephanosphæra. The period of rest here is then almost null, and if regard were paid to the character drawn from movement it would be necessary to make stephanosphæra and its allies true animals. The green color of the constituent cells, the resemblance of the zoospores to those of hydrodyction, which, through the duration of their period of rest, are true algæ, are the only reasons for referring the volvoces to the vegetable kingdom.

On the contrary, we more willingly refer to the animal kingdom the remarkable magosphæra planula discovered by Hæckel in 1869 in the North Sea, and which nevertheless exhibits certain analogies with the volvoces. In the adult state a magosphæra (Fig. 3, Nos. 3 and 4) has the aspect of a small sphere composed of thirty-two pyramidal-shaped cells, the apices of which are united at the center of the sphere, and the bases of which reach the latter's surface, where they are arranged like mosaic. The entire free surface of the cells is covered with vibratile cilia, and the magosphæra swims, like a volvox, turning over and over as it goes. At a certain moment the sphere undergoes disaggregation, and the cells, set free, move around after the manner of amœbæ (Fig. 3, Nos. 5, 6, 7); then they assume the spherical form, and become surrounded by an enveloping membrane (Fig. 3, No. 1). Nothing then serves to distinguish them from the eggs of animals. The egg of magosphæra does not need to be fertilized; its contents, by a series of successive bipartitions (Fig. 3, No. 2), give rise to thirty-two cells, at first independent, which are constantly performing amœboid movements. But soon all become regulated; the cells become attenuated toward the center of the cyst, and assume the radiating form which we already know, and they cease their amœboid movements except at the surface. In the same way the pseudopodia which they put forth cease to become retractile, while they still continue to move, and thus they form the ciliated covering of the sphere. Finally, the cyst ruptures, and a new magosphæra is set free. The history of the development of this organism shows us an interesting fact: the transformation of pseudopodia without definite form, essentially transitory and in some sort accidental of the amœboid mass, into clearly defined organs of constant form—the vibratile cilia. Distributed throughout the entire animal kingdom, playing an important part in the economy of higher beings, and in man even (whose wind-pipe and bronchiæ they clothe with a continuous layer), these organs are only simple prolongations of the cellular protoplasm which, while losing the faculty of changing form, yet preserve the primordial faculty of movement.

Naturalists who regard chlorophyl as a characteristic of plants would be disposed to relegate the magosphæra to the animal kingdom, but we have seen how little value this character possesses. The magosphæræ then are very ambiguous beings, and that does not mean, please observe, that if naturalists do not know where to place them now, they will not be able to decide some day; it means simply that these organisms are neither animals nor plants; they are composed of the same materials as the latter, but these materials have not yet acquired either the mode of grouping or the characters which distinguish them in the two kingdoms.

Equally as much may be said of that curious labyrinthula macrocystis discovered at Odessa by Cienkowski, on piles submerged in the sea. Imagine a sort of mucous network, in which can glide about and revolve cells of an egg-yellow color, sometimes isolated and sometimes aggregated into irregular masses, and you have this strange object. The mode of reproduction and development of labyrinthula is as yet little known. Here, also, the green coloring matter is entirely wanting; but it is also absent in the myxomycetes, which, during the greater portion of their existence, might be taken for animals, and which, nevertheless, a consideration of their reproductive organs obliges us to regard as true fungi. The type of this group of myxomycetes is an organism which develops abundantly during the summer on masses of oak or beech shavings. The organism is itself well known; it is the "tan-bark fungus," or "flowers of tan," called by botanists æthalium septicum. It forms orange-colored mucous masses of a pretty large size, and which are seen to emit from every portion prolongations analogous to the pseudopodia of amœbæ; and these prolongations are apt to become fused together so that the entire mass has often a reticulated appearance like that that we have already seen in bathybius. It dissolves foreign matters and feeds upon them, just as an animal does. At the end of summer all changes; on the surface of the tan there are formed large cakes, sometimes 12 inches in diameter and one inch thick. These are at first of a beautiful yellow, and afterwards become brown. They are formed of a sort of rough crust, beneath which is found a closely felted mass of tubes anastomosing like network. Each of these tubes contains others that are much more delicate, and forming a new network, within the meshes of which are imprisoned the minute spherical spores which are to reproduce the æthalium. The delicate tubes which surround the spores are called the capillitium, and the large tubes which contain the smaller ones are called sporangia. The colored crust which protects these tubes in æthalium is wanting in the majority of the other genera. In physarum these tubes are independent of each other; and they are replaced by small isolated spheres in arcyria (Fig. 4, No. 2); and, finally, the capillitium is wanting in licea and cribraria. In all cases it is the entire mucous mass of the myxomycetes which is transformed into organs of fructification. The rugose crust which forms, in æthalium, the outer wall of the organ, is nothing else than a portion of this mass, in which are assembled all the solid foreign substances that the protoplasm contained at the moment of fructification. The spores of myxomycetes placed in moisture swell, their wall bursts,

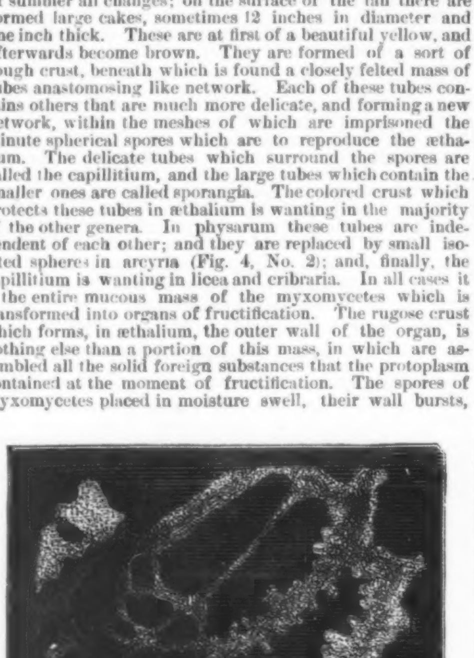

FIG. 4.—MYXOMYCETES.

1. *Didymium leucopus* during its amœboid phase. 2. Closed sporangium of *Arcyria incarnata*. 3. Sporangium after emission of the spores; the *Capillitium* still adherent to the walls of the organ.

and their protoplasm, becoming free, immediately exhibits amœboid movements; little by little, however, its form becomes fixed, and one of its extremities tapers into a long mobile cilium, by the aid of which the true zoospore, thus constituted, can swim in the surrounding liquid. These zoospores reproduce themselves a certain number of times by division; and finally a certain number of them again assume the amœboid appearance, become fused together, and form in that way a young myxomycete, which has nothing to do but to grow larger to reproduce the protoplasmic mass that we first spoke of. When, in this long series of phenomena, dryness intervenes, the zoospores, or the young myxomycetes which result from their fusion, surround themselves with an enveloping membrane, become encysted, and await in this state the return of moisture. Under these same circumstances the protoplasmic masses, which are already of considerable size, resolve themselves into an infinite number of little spherical bodies, each inclosed in its membrane and fitted for reproducing as many new individuals.

In all that we have just said there is evidently nothing that will allow us to conclude that the myxomycetes are plants; but, on the contrary, their movements and their mode of alimentation would tend to cause them to be regarded as animals. Some eminent botanists, like De Bary and Rostafinski, have maintained (one in 1866 and the other in 1873) that these beings are certainly animals; but other naturalists have proved that the passage of myxomycetes to true fungi takes place by imperceptible gradations. According to Famitzine and Woronine, the myxomycetes pass into ceratium on the one hand and into polyporus on the other through ceratium hydnoides and polysticta reticulata. Max. Cornu establishes, besides, their passage to the saprolgniæ (small fungi parasitic on decomposing animal matters) through the chitridia, these being themselves parasites on the saprolignæ. In the presence of so many affinities it is impossible to separate the myxomycetes from the fungi; and in them must be seen the form of that group which is most approximate to the initial state of organisms of the non-differentiated state corresponding to an epoch of development of life in which there was as yet neither animals nor plants, but protoplasmic beings having within them the power of becoming such.

Observe that we find in the myxomycetes three forms succeeding one another, and which we have already had occasion to point out so many times: (1) the amœboid form, in which a protoplasmic mass, deprived of enveloping membrane, moves, while continuously modifying its outlines; (2) the ovulary form, in which the mass becomes spherical, surrounds itself with a membrane, and, thus protected, undergoes different modifications which are usually connected with the phenomena of reproduction; (3) the flagellate form, represented by a small ovoid mass of protoplasm furnished with a long filament, constantly in vibration, and which serves as a locomotor organ.

The two latter forms have, in the majority of beings that we have just studied, a shorter duration than the first, and they do not attract so much attention because the eggs are immovable, and both these and the zoospores are of minute size. The ovulary form, whatever be its duration, can moreover be considered only as transitory, for it implies a period of apparent rest which, in reality, is a period of internal elaboration, preparing in the protista the passage from the amœboid to the flagellate form. It is not the same with the latter, for which naturalists have had to form a special class of flagellate infusoria, and which might more properly be called flagelliferous infusoria. We will proceed to the study of these in our next article.

(*To be continued.*)

ANTHROPOMETRICAL MEASUREMENTS.

THE department of anthropometry, of so much importance to the science of anthropology, has recently been carried to great perfection and its method extensively applied. Some very curious and very interesting results have thus been obtained; some of the most interesting of these have been recently published by Dr. A. Weisbach, chief physician to the Austro Hungarian hospital in Constantinople, who, Dr. Von Scherzer tells us, has probably taken more measurements of living men than any other anthropologist. Dr. Weisbach's measurements refer to 19 different peoples and more than 200 individuals from the most various parts of the earth.

The most interesting of these measurements refer to the pulse, the length of the body, the circumference of the head, the height and length of the nose, as well as the comparison of the length of the arm and bones with each other. Thus, for example, the number of pulse-beats per minute varies within wide limits: the Congo negroes, 62; and next to them the Hottentots and Roumanians, 64, have the slowest pulses. Then follow the Zingani, 69; Magyars and Caffres, 70; North Slavs, 72, and Siamese, 74; Sundanese and Sandwich Islanders, 78; Jews, Javanese, and Bugis, 77; Amboinese and Japanese, 78; and lastly the Chinese, 79. The quickest pulses belong to the Tagals, 80; the Madurese and Nikobars, 84.

As to height, the smallest among the peoples measured are the Hottentots, 1,286 millimeters; this is far behind any other people; as the next, the Tagals, are 1,562. Then follow the Japanese, 1,569; the Amboinese, 1,594; Jews, 1,599; Zingani, 1,609; Australians, 1,617; Siamese, 1,622; Madurese, 1,628; South Chinese, 1,630; Nikobars, 1,631; Roumanians, 1,643; Sundanese, 1,646; Javanese, 1,657; Magyars, 1,658; Bugis, 1,661; North Slavs, 1,671; North Chinese, 1,675, and Congo negroes, 1,676. The longest measurements, however, are found among the Sandwich Islanders and Kanaks, 1,700 millimeters; Caffres, 1,753; and the Maoris of New Zealand, 1,757. To compare these with the stature of European peoples, we find that that of the English and Irish is 1,690 millimeters; the Scotch, 1,708; Swedes, 1,700; Norwegians, 1,728; Danes, 1,685; Germans, 1,680; French, 1,667; Italians, 1,668; and lastly, Spaniards and Portuguese, 1,658.

The greatest circumference of the head is found among the Patagonians, 614 millimeters, and Maoris, 600. Following these are the Caffres, 575; Nikobars, 567; North Slavs, 554; Congo negroes, South Chinese, and Kanaks, 553; Tagals, Sundanese, and Roumanians, 552; Japanese, 550; Bugis and Jews, 545; Amboinese, 544; Javanese, 542; Hottentots, 540; and, lastly, the Zinganis and Siamese, 529.

Stature and circumference of head generally stand to each other in opposite relations; although there are exceptions, as in the case of the Siamese with small stature and small head, and the Patagonians with great height and large head. The breadth of the root of the nose is found greatest among the Patagonians, 41 millimeters; less among the Congo negroes, 36; Australians, and South Chinese, 35; Sundanese, Amboinese, Nikobars, Tagals, and Kanaks, 34; North Chinese, Caffres, North Slavs, Roumanians, Magyars, and Zinganis, 33; Jews, Japanese, Siamese, Javanese, and Hottentots, 32. The Jews and Patagonians excel in length of nose, 71 millimeters. Following these are the Kanaks, 54; Roumanians, 53; North Slavs and Maoris, 52; Tagals, 51; Japanese and North Chinese, 50; Siamese, Magyars, Zinganis, Madurese, 49; Amboinese, 48; Nikobars, 47; Sundanese, Javanese, South Chinese, Caffres, 46; Hottentots, 44; Congo negroes, 42; Bugis, 41, and Australians, 30. The breadth of the nostrils gives quite another arrangement. Here we find the Australians excel, being 52 millimeters; then come Congo negroes, 48; Caffres and Patagonians, 44; Tagals, 42; Nikobars, 41; Hottentots and Sundanese, 40; Malay races, 39; South Chinese, 37; North Chinese, 36; Japanese, North Slavs, Roumanians, Zinganis, 35; Magyars and Jews, 34. With regard to the bust, it is found that the North American Indians and the Polynesians excel all others in size. Next to them come the North, Middle, and East Europeans; after them come the West Europeans, negroes, and after them the South Europeans, who are followed by the East Asiatics and Malays.

Among European peoples, in respect of race, we find the narrowest chests among the Semites, followed in order by Romanee, Celts, Fins, Zinganis, Germans, and Slavs. Interesting results are obtained by comparison of the length of arm and the leg bones. Among East Europeans the leg bones throughout are longer than the arm; among Australians, Polynesians, and especially East Asiatics and Patagonians the leg bones are shorter than the arm; among Africans only the Congo negroes have the leg bones longer than the arm. Dr. Von Scherzer, to whose paper we are indebted for these details, points out some important conclusions to be drawn from these *data* as to the classification of races of men; these we have not space to go into. While, of course, it would be quite misleading to build any classification upon anthropometric measurements alone, their importance, when obtained in large numbers and with trustworthy accuracy, as a help to anthropologists is very great.—*London Times.*

THE WISCONSIN PICTURED CAVE.

Report of Rev. Edwin Brown to the State Historical Society at Madison, Wis.

This curious cave is situated on the farm of Mr. David Samuel, in the town of Barre, four miles from West Salem and eight miles from La Crosse, on the northwest quarter of section twenty, township sixteen north of range six. It was discovered in October, 1878, by Frank Samuel, a son of Mr. Samuel, eighteen years of age, who had set a trap for raccoons at a hole of considerable size in a hill. Finding that he could with a little difficulty crawl into the aperture that had been made by wild animals through a land slide at the foot of a cliff of Potsdam sandstone, he entered, and, finding it opened into a spacious cavern, he procured lights, and, with two older brothers and a friend, explored it. They found the walls extensively covered with rude pictures and hieroglyphic characters, carved in the stone, and charcoal paintings. For six months it was known only to the near neighbors, and visited chiefly by boys, who built fires and carved their names upon the stone, and made pictures of their own, sometimes defacing the original ones.

About the first of June, 1879, I heard of such a cave with such pictures and characters, and immediately visited it. I quickly saw that there was something of much value to archæological science. That these rude pictures and carvings were quite old. That what is now a close chamber had been one open cavern in the cliff, and had been closed not less than 150 years by a land slide from the hill above, as a poplar tree twenty-four inches in diameter, with 120 circles of growth, which stood as a dry tree, when Mr. Samuel first occupied the land twenty-five years ago, and had rotted and fallen, had grown upon it; and a birch tree standing upon the edge of the cliff where the slide went over indicated in the same way from 150 to 160 years. I visited Mr. Samuel, and informed him of the value of the inscriptions and possible discoveries to be made by digging. He immediately took measures to stop the vandalism that was destroying them, to enlarge the opening, and clear out the sand that had washed in from the land slide and half filled the cave. In the meantime I set about searching out the pictures and characters and taking facsimiles by pressing tissue paper into the grooves, and, with black crayons, following each line to its termination; preserving also its original width. In this way I got perfect outlines, and, by placing other sheets over them in the light of a window-pane, took smooth copies, that showed the pictures in their original form and size. I sent one set to Professor Chamberlain, State Geologist, not intending to make anything public till an archæological expert had examined and pronounced upon them and their value to science had been ascertained. In the meantime, it having been noised about that I was examining such a cave, I was called upon by the local editor of the *Chronicle*, of La Crosse, to whom I gave copies of some of the most prominent of the pictures, from which hasty wood-cuts were prepared, which appeared in the *Chronicle*. This report was seen by Mr. Lyman C. Draper, who wrote to me for information in regard to it. I sent him copies of the pictures, as far as I had taken, and set a time to dig into the bottom of the cave, and requested him to come or send a competent archæologist. He communicated with Dr. J. A. Rice, of Merton, Waukesha County, who came, at the time appointed, with Mr. Rockwell Sayer, of Chicago. A company of seventeen men repaired to the place, with shovels, wheelbarrows, and other necessary things for a thorough exploration. Several intelligent ladies also accompanied them, with a picnic dinner. Commencing at the back end of the cave, the sand was carefully dug up and wheeled out, and every load minutely inspected, and the work continued until every part had been examined. We came upon four layers of ashes, from two to four inches in depth, containing charcoal and burned and nearly vitrified sand rock. They were separated from each other throughout the whole length and breadth of the cave by layers of clean, white sand of from ten to fourteen inches in thickness. Below the whole was water of the same level as the marsh that lay in front of the cliff. The lower stratum of sand and ashes contained nothing. In the second were fragments of smooth pottery made of clay and ground shells, the oldest kind found in mounds. In the third were larger pieces of more elaborately wrought pottery (the newest found in mounds), with numerous fragments, and whole sides of Mississippi River bivalve shells, and a bone bodkin made of what old hunters call the "hock bone" of an elk. This was in dry white sand, and is quite sharp, smooth with use, and in a perfect state of preservation, even retaining the glossy polish of handling, as if used but yesterday. All the layers had become compact and well stratified, and all contained charcoal, charred wood, and rotten wood. We found no bones except in the upper stratum, two hollow bones of birds and two of small quadrupeds, a cartilaginous maxillary of some reptile, and a "due clon" of a deer.

The four completely diffused strata of ashes, separated by a foot average of clear sand, showed that there had been four distinct periods of occupancy, separated by considerable intervals of time. The lapse of time was also indicated by the two orders of pottery, one always below the other, but there was nothing to measure the time. The only conclusion we could arrive at was that the first occupancy was very ancient, and the last before the land slide, or not less than 160 years ago. Before the land slide it was an open shelter cavern fifteen feet wide at the opening and seven feet at the back end; greatest width, sixteen feet; average, thirteen feet; length, thirty feet; height from the level of the water, thirteen feet; depth of sand and ashes, after the yellow sand of the land slide had been cleared out, five feet. The pictures are mostly of the rudest kind of art, but differing in degree of skill. One, representing a man with eight plumes on his head, Dr. Rice explains to mean, in the hieroglyphic language of Indian tribes, that he had taken eight scalps of the enemy.

One represents a man, with bow and arrow, shooting at some large animal. Except a picture of an elk, several of bisons, a rabbit, lynx, otter, and a heron, it is difficult to determine what animals were intended, or whether they represent large or small ones, no regard being had for proportion. A bison, lynx, and rabbit, all pictured in one group, are all of one size. One picture suggests to the beholder a mastodon, and another, the largest, the hippopotamus. But whether they were intended to represent these animals is uncertain. If they are not, they are probably all the representations of animals that are still extant. Many of the pictures are fragmentary by the erosion of the soft, white sandstone on which they are engraved. In one place there is a crevice made by such erosion, eight feet long and two feet high, extending inward two and one-half feet, with fragments of pictures above and below. (Another proof of a considerable lapse of time since they were engraved.)

The appearance and connection of the pictures and characters indicate that they were historical rather than engraved for mere amusement, and suggest that thorough examination of caves may yet shed much light on the history of the prehistoric aborigines of our country.—*La Crosse Chronicle.*

NOTE ON THE DISCOVERY OF A HUMAN SKULL IN THE DRIFT NEAR DENVER, COLORADO.

By Thomas Belt, of London.

(The talented author of the above named paper was elected a member of the American Association for the Advancement of Science at the St. Louis meeting, 1878, and was present two or three days, when a dispatch recalled him to Colorado, where he suddenly died, a month later, on the 28th of September, 1878. His unexpected short stay in St. Louis prevented him from making a complete description of his discovery, and forced him to omit a discussion on the age of the deposit, in which the skull was found, altogether. Mr. Belt's courteous and genial manner won him the respect of all who were so fortunate as to meet him.)

Abstract.

In passing westward from the Missouri to the Rocky Mountains through Nebraska, Northern Kansas, Wyoming, and Colorado to the upper member of the drift series, the equivalent of the brown clay of Illinois is found to be continuous up to the base of the mountains. Drift gravel is generally found below it or is contained in patches in it. Nearing the mountains the clay is of a darker color and a more sandy texture, and has often pebbles and stones scattered through it. Large bowlders are also met with near the mountains, and beds of sub-angular bowlders and pebbles, nearly always of crystalline rocks, skirt the flanks of the mountains, run up the sides of the valleys opening into them, and cap isolated hills in front of them to heights of about 8,000 feet above the sea.

In the neighborhood of Denver the sandy clay covers the whole country, excepting on the steeper slopes, where it is sometimes absent from denudation. It is often as much as 30 feet in thickness, and contains here and there bowlders of crystalline rocks scattered through it. In some of the sections these are sufficiently numerous to make it a bowlder-clay. Much of it is unstratified and with vertical joints.

Whilst examining the sides of a cutting through this deposit on the Colorado Central Railway, near the top of the low watershed between the South Platte and its tributary, Clear Creek, I noticed a whitish substance on the face of the cutting. On clipping round it with a knife it proved to be the top of a human skull. It was in perfectly undisturbed loess-like clay, at a depth of three feet nine inches from the surface. At the same horizon at intervals were small angular pieces of miocene wood. No other bones were found, and none of the teeth. Seventy yards distant I found what appears to be a portion of a human rib.

Isolated bones of other animals than man are not uncommon in the neighborhood of Denver and near the foot-hills in the brown clay and associated drift gravels. Besides those found by myself, Prof. Lakes, of Golden, and Mr. H. C. Towner, of Denver, have collected many specimens. Among these, bones of the common buffalo seem to be most frequently met with.

(The several fragments of the human cranium were seen by a large number of the members of the Association at St. Louis.)

THE GEOLOGICAL MUSEUM OF THE SCHOOL OF MINES, COLUMBIA COLLEGE.

By Israel C. Russell.

As it is impossible for every one to visit distant lands, or even at all seasons to go forth into the fields and among the mountains in quest of geological knowledge, we desire to call the attention of our readers to a collection in our country which in a great measure will supply these wants. We refer to the Geological Museum under the direction of Prof. J. S. Newberry, at the School of Mines, Columbia College, New York city. Here the visitor will find a most interesting display of the remains of the ancient inhabitants of the globe, gathered not only from the rocks of our own country, but also from the most distant lands, and each arranged in its proper place in the long series.

The geological museum occupies the entire third story of the eastern wing of the School of Mines building, and consists of four collections, all of which, however, have an intimate connection with each other. The first and most interesting of these is the geological and palæontological collection, which will be the subject of our present sketch. This is supplemented (firstly) by a lithological collection, consisting of three thousand specimens of rocks and the minerals which compose rocks; (secondly) by a collection in economic geology, containing nine thousand specimens of coal, ores, marbles, fertilizers, etc., illustrating the mineral wealth of our country, and containing also suites of ores and associated rocks from many of the most important mines in foreign lands; (thirdly) as an aid to the study of the fossil remains of animals and plants, which constitute the most attractive branch of geological knowledge, a zoological and botanical collection has been added, composed of well selected specimens which in some peculiar manner serve to explain the fossil forms. This collection in some departments, as in that of fishes, contains many remarkable and interesting and valuable specimens.

The portion of the museum to which we wish to introduce the reader is the first we have mentioned, that of geology and palæontology. This collection occupies the wall and table cases on the eastern side of the hall; many large specimens, however, as the skeleton of the Irish elk, a cast of the megatherium, etc., are arranged in various parts of the museum.

The cases, commencing at the northern end of the hall and extending throughout its entire length, present the geological records from the earliest dawn of life on our planet down to the last chapter in its history—the introduction of man.

These sibyl's pages, gathered from the ends of the earth, present an epitome of the world's ancient history written by the unprejudiced hand of nature. These fragments of stone, with the curious forms of animals and plants engraved upon them, are to the geologist—the interpreter of the earth's history—what the hieroglyphics of Egypt or the picture writings of Mexico are to the archæologist—the translator of human history.

Before we enter into an examination of the remains of animals and plants which once lived upon the earth, but are now extinct, we should clearly understand that fossils are the records which these ancient organisms have left of their existence. In some instances, as with the Irish elk and the moa of New Zealand, we find the bones themselves but little altered from their original condition. At other times the organic matter of the specimen, a piece of wood, a bone, a shell it may be, have been replaced by silica so as not only to retain the general form, but even the most minute structure of the original substance. Such a replacement is called petrifaction. Wood is frequently thus petrified so as to preserve its microscopical structure as perfect as it was when the plant was yet in leaf. Again we may find but the impression of a fern or of a fish, made in soft mud or sand, which has been hardened into rock and has faithfully preserved the form of the frail body that perished ages ago. The plastic mud along the shores of bays and rivers is frequently trodden by animals or pitted by falling rain drops; such a surface by becoming covered by a layer of sand or mud may retain for indefinite ages the inscriptions thus impressed upon it. In these and many other ways the life history of distant ages has been written on the rocks and preserved to our own day, with an accuracy and fidelity which cannot be too highly appreciated.

The great interest connected with the first appearance of life on the globe is indicated by the prolonged discussion that took place in reference to the organic nature of the Eozoön, which, as far as at present known, is truly the "dawn animal" of the world. Specimens of this interesting fossil are contained in the first case at the northern end of the geological hall. Now that we have made the first step in our journey through the geological ages as here arranged, we will pass slowly down the long row of cases, and in doing so, review hastily the life history of the earth.

The Eozoön belongs to the lowest sub-kingdom of animal life, the *Protozoa*, which also embraces our familiar sponges, the structureless amœba, etc. The case containing the Eozoön shows us also the forms of life that followed this humble beginning. These are the fossils of the Silurian age, or the age of mollusks, as it is sometimes called in reference to the great abundance of the remains of "shell-fish," which far outnumber all the other fossils of this formation. The collection contains six thousand specimens of this ancient fauna, which were all embraced in the first four sub-kingdoms of animal life. The *Protozoa* are represented by the Eozoön, sponges, receptaculites, etc.; the Radiates by corals, crinoids, and star fishes. The Mollusks, as we have mentioned, were in great force, as the fossil shells testify. The numerous trilobites, with the Eurypterus, Pterygotus, etc., show us that the Crustaceans were the highest form of life on our continent during the Silurian age. But while the Crustaceans were the highest in point of structure, yet they were far inferior in size and strength to the Cephalopods, the highest of the Mollusks, which lived in the same seas. These were represented by huge Orthoceratites. As we stand beside the cases containing these beautifully preserved remains, it is not difficult to restore them once more in fancy to the ancient waters in which they lived, and to picture to ourselves the appearance of the earth in that distant age. All the remains of animal life which these cases contain are those of marine forms. All the remains of plants, too, discovered in the rocks of this age have been classed with the Algæ (or sea weeds). Judging from the fossil records, which, however, we feel are incomplete, we conclude that no plants grew upon the Silurian land areas.* There was then but the broad ocean and the wild desolate shores, uninhabited by beast, or bird, or plant—even more dreary and silent than are now the barrenest islands of the southern oceans. Along these primeval shores the waves rolled in and ground away the rocks as they do on the coast to-day, and retreating left the sands with a ripple-marked surface or covered with the trails of worms and crustaceans. Many of the shell fish and trilobites lived along the shore, perhaps sheltered by clumps of seaweed and clinging brachiopods; others inhabited deeper waters and contributed their remains to the formation of the limestone in which we now find them.

With this imperfect glimpse of our country in the Silurian times, we must pass on to the fauna and flora of the next succeeding, Devonian, age. Again naming the era from the ruling forms of life, we call this the age of fishes. Although in Europe the first fishes made their appearance in the preceding age, yet in our country we find their earliest remains in the Devonian rocks, throughout which time they continued to be the highest forms of life on the globe. What at once strikes the observer upon glancing over the splendid display of Devonian fossils here brought together, is the almost total absence of the forms with which we have already become familiar in the Silurian. Here begins a new chapter in the ancient archives. The few inches that separate the Silurian from the Devonian fossils represent in reality an immense lapse of time, during which the fauna of the world underwent great changes. We will not say that all the old forms of life were exterminated and new beings created to take their places, nor can we prove that during these unknown ages the laws of development were slowly changing the plastic organisms into new forms better adapted to meet the altered conditions under which they were forced to live. We can only say that the record is broken; to-morrow the missing chapters may be discovered and new light thrown upon the enigma, but to-day we must pass it by. But while most of the fossils of the Devonian differ in genera and species from those of the older fauna, yet they belong to the same families and orders, with the exception, of course, of the fishes, which are new to the life of the world. The corals, mollusks, and crustaceans are present in great numbers, and in a general way resemble their representatives in the Silurian, but on the whole they present greater diversity and indicate more advanced conditions. The presence of corals in the rocks of this age in what are now the Arctic regions, indicates that there was little diversity of climate at the time these animals were alive.

The fossils which particularly attract the attention in these cases, and which will always be a center of interest to the student of the Devonian, are the remains of fishes, of which this collection contains a grand display that is unrivaled by any other museum in this country. Many of these fossils are unique, and in some instances are the only specimens of their kind known, many of them being the types figured by Prof. Newberry in the Geological Reports of Ohio. Among the first objects to attract the attention are the great sword shaped spines which are the type specimens of the genus *Machæracanthus*; these highly polished spines, some of which are twenty inches in length, are samples of the weapons worn by the old Devonian sharks. These ancient fish spines illustrate the economy that is shown in so many of nature's works, in gaining great strength with the use of the

* Since this was written a number of species of land plants have been described from the Silurian rocks of our country by Mr. Leo Lesquereux.

smallest possible amount of material. Here also are the type specimens of the genera *Acanthaspis* and *Acantholepis*, which show a strange combination of plate and spine that is unknown in modern fishes. Another slab of limestone shows the head of an old Devonian fish that measures seven or eight inches in length. The head of this fish was completely incased with solid bony plates that were strongly united by sutures and highly ornamented on the exposed surfaces. This fish, which has received the long name of *Macropetalichthys*, seems to have had many features in common with the structure of the living sturgeon. One of the strangest fishes that ever swam in the Devonian seas, and which surpasses in interest even the *Pterichthys* and *Coccosteus* of the old world, is the *Onychodus*. Among the most unique specimens in the museum is a slab of limestone from the Corniferous rocks of Ohio, containing a nearly perfect mandible of this fish, which is fourteen inches in length and set with sharp conical teeth. At the junction of the two rami of the lower jaw there occurs a crest of seven large curved teeth which seem to have projected beyond the massive jaws, thus forming a terrible weapon, whose use seems to have been analogous to that of the sword in the living sword fish. Far more wonderful than any of these, and one of the strangest monsters ever exhumed from the cemeteries of the primeval world, is the *Dinichthys*, described by Prof. Newberry from the Huron shales of Ohio. The nearly perfect bony casing of this "terrible fish," which is exhibited, shows it to have been upwards of twenty feet in length; and judging from its formidable armament, it was by far the most destructive creature yet known from the Devonian rocks. The jaws are massive plates of dense bone, each two feet in length, and provided with sharp cutting and serrated edges. The anterior ends of the mandibles are upturned and united so as to form one immense tusk-like tooth, which shuts in between two equally massive premaxillaries on the upper jaw. The jaws of *Dinichthys* may be well represented by the arms of a man extended to their full length with the hands turned up and pressed together to represent the great tooth at the junction of the mandibles. One of the most curious and interesting features connected with this discovery, is the striking analogy that exists between the structure of the *Dinichthys* and the mud fish (*Lepidosiren*), now living in the rivers of Africa and South America. The number of these Devonian fishes is so great that we can but glance at a few of the more interesting ones that remain. Beside the dorsal shield of *Coccosteus* from the Old Red Sandstone of Scotland, is placed the only similar specimen known of *Coccosteus* from this country. Here too is the type specimen of the genus *Heliodus*, one of the most ancient of the Dipnoi. Specimens of *Rhynchodus* show us that the modern Chimæra belongs to a very ancient family.

We cannot linger over these ancient relics, which are but waiting the pen of a Hugh Miller to make them familiar to every reader in our land, but must pass on to other features of the Devonian, which are well exhibited in these cases. Our readers will remember that the shores of the Silurian ocean were barren solitudes. Not so was it in the Devonian. We have here before us the remains of a strange and luxuriant flora that shaded the land. Ferns grew luxuriantly; above these flourished the strange *Lepidodendrons*, with which we shall become more familiar in the age that follows. We have here the first appearance of the most beautiful of land plants, the tree ferns, which at the present day form such an attractive feature in the scenery of the tropics and of the islands of the South Pacific.

The next series of cases contains the remains of the fauna and flora that flourished in the carboniferous times—the age which witnessed the formation of the great coal fields of America. Here the scene again changes. The mollusks and crustaceans, the huge ganoids and the strange flora, of the Devonian age, have disappeared never to return again. Another cycle in the world's history has been completed. The fossils which we have now to examine are, as before, the remains of shells, fishes, plants, etc., but all very different from those of the Devonian. Fishes appear again in great numbers, but not the huge Placoganoids that we saw before, but the elegantly formed Lepidoganoids, covered with little plates of enameled bone. The most beautiful of these fossil fishes are from the cannel coal deposits of Linton, Ohio. The fossilization in these specimens is peculiar. Each little plate of mail and each delicately penciled fin seems wrought in gold leaf on a black ground. In reality, the substance which represents the fish is iron pyrites, on a surface of impure coal. These little fishes have received the generic title of *Eurylepis*, in reference to the breadth of their scales, and such specific names as *corrugata*, *insculpta*, *lineata*, *ornatissima*, etc., suggested by their delicate ornamentation. Specimens of *Cœlacanthus*, which occur with the *Eurylepis*, are even more highly ornamented, and have their scales and head plates so elegantly chased that the most skillful gem engraver could scarcely imitate their delicate tracery. The great fin spines which these cases contain show that the sharks were strongly represented in the Carboniferous waters. Here, too, are the teeth of the most gigantic ray ever discovered (*Archæobatis*), some of the flat crushing teeth of which were six inches in length, four inches wide, and an inch and a half thick.

Some of the slabs of stone from Linton, Ohio, upon being split open, showed the heads, limbs, scales, etc., of *Amphibians*, represented at the present time by the frogs and salamanders. It is at once apparent that this is the heading of a new chapter. In all the stony pages that we have glanced over, we have not seen characters like these. If we should follow out the records here begun, through all the following ages, we would find, indeed, that it is a chapter of wonders, containing the lives and struggles of the hugest and strangest monsters that have ever lived. We cannot pass on, however, without glancing at the flora of the Carboniferous, the relics of which these cases contain to overflowing. These forms, that are traced so delicately on the stones, were once living plants that millions of years ago bowed to the passing winds and drank in the sunshine as our most familiar trees and ferns do to-day. These fragments of trunks, branches, leaves, and cones give us a faint glimpse into the dark moist forests that clothed our land in the coal period. Many of the fossil plants we at once recognize as ferns, so nearly do they approach in form these beautiful plants which we meet in all our rambles. Others, after considerable study, have been shown to be closely related to the little ground pines or club mosses, which are also quite common in our woods. These ancient Lycopods, however, instead of being only a few inches in height, with cones an inch long, were gigantic trees, sometimes upward of seventy or eighty feet in length, with elegantly scarred trunks, and bearing large cones upon their gracefully pendent boughs. Another of our common plants, the Equisetum, also had giant representatives in the ancient flora. These, together with the Sigillarias, with their beautifully fluted columnar trunks, furnished the material from which our great stores of coal were formed. What at once appears as a remarkable fact upon looking over these fossils, is that they all belong to the lowest grade of vegetation, the cryptogamous or flowerless plants. Among all the hundreds of coal plants here assembled, we look in vain for so much as a single leaf of a broad-leaved plant like our maples and oaks. It was long supposed that there was a total lack of flowers in the Carboniferous forests, but a specimen in this collection shows a branch of some unknown plant with the remains of flowers clearly distinguishable.

As we pass on to the records of the next succeeding (Mesozoic) eras, the mediæval age of geology, we find no mention made of the luxuriant forests and the abundant animal life that passed before. Nearly all remembrance of these seems lost in antiquity. This age, in reference to the predominating forms of life, is called the reptilian age. The first indications that we have of these new rulers of the land and sea are their footprints, left along the muddy shores. Some of these from New Jersey and the Connecticut valley are shown in the case of Triassic fossils. These wonderful impressions are so well known through the writings of Prof. Hitchcock and others that we need do no more than mention them. The rocks in which these footprints were found have also furnished a great number of fossil fishes. Among hundreds of specimens of these Triassic fishes here assembled, there is one called *Ptycholepis*, with highly ornamented head plates and plicated scales, which is the only American specimen known of this genus, which occurs in the Lias of Europe; here, too, is the only specimen yet discovered of *Diplurus*; this was lately obtained from the Triassic rocks at Boonton, N. J. The rocks of this age have also yielded the oldest remains known of the Mammalia. This sub-kingdom makes its appearance in one of its humblest orders, the Marsupials, represented at the present day by the opossum and the kangaroo.

In the flora of the earlier portion of this age we find ferns, calamites, and conifers, with the addition of a new feature, the Cycads. As we pass on to the cases containing the fossil plants from the latest period of this age, the Cretaceous, we come suddenly to a splendid display of fossil leaves which have a wonderfully familiar appearance; they are the leaves of oaks, willows, maples, beeches, sycamores, etc., which the most casual observer would refer to the same genera that are living at the present day. There are differences which show that all these fossil leaves are specifically distinct from their modern representatives.

Among the most striking forms of animal life in the Mesozoic, were the Cephalopod shells, related to the living nautilus. Of these, the ammonites, which were foreshadowed by goniatites in the Devonian and Carboniferous and began to assume their characteristic elegance of outline in the Triassic, in the Cretaceous attain a degree of variety and beauty that could with difficulty be excelled. It is interesting to observe that after these mollusks had slowly attained this surpassing degree of elegance and ornamentation, the whole family became extinct. The collection contains many of these chambered shells from the Cretaceous of the Upper Missouri, which still retain their nacreous walls, that after the lapse of ages are as beautifully iridescent as any living shell. Here also are the bones of some of the great reptiles of the Cretaceous, the teeth of fishes, and a great variety of shells and plants from the same rocks. Many of these specimens are of great scientific value, as they are the type-specimens upon which many of the genera and species of Cretaceous fossils were founded.

The last case at the southern end of the geological hall contains the fossils of the Tertiary period, the last period but one before the age of man. A glance at the contents of this case shows us that all the grand divisions of animals and plants which are living at the present day are represented. The shells of this period exhibit a very modern aspect, especially when compared with the older ones we have been studying; although many of them belong to living genera, yet nearly all the species are extinct. The Tertiary plants, which are shown in great abundance, prove that the flora was not very different in its general character from that clothing the Middle States at the present day. The higher vertebrates at this time appeared in such numbers and variety that this age is known as the age of mammals.

While lingering over the cases of Silurian fossils, we attempted briefly to retrace the picture of that age, with its small and barren land areas and its great oceans tenanted by the lowest forms of animals and plants. Let us contrast with the silent barren aspect of our continent in those primeval days, its appearance in Tertiary times. North America had then attained nearly its present outline, although extensive regions along the Atlantic and Gulf borders were yet beneath the ocean, and great lakes occupied the western interior. A flora of temperate or sub-tropical growth clothed the area of the United States, and the climate of Virginia reached as far northward as Greenland. The splendid collection of Tertiary plants from the region of the Upper Missouri, the Yellowstone, and other portions of the West, shows that the banks of the Tertiary lakes, which then existed at these localities but have since been filled, were fringed with a varied and beautiful vegetation. We find among these fossil plants the leaves of the maple, oak, hickory, conifers, etc., together with others that now grow far to the southward, as the palm, magnolia, cinnamon, and fig. Many of these fossil leaves are of double value, as they are the type specimens from which Prof. Newberry has described and figured this wonderful flora, rich both in species and individuals. When we inquire what animals lived in these luxuriant forests, a vast menagerie of strange forms passes before us. We can do no more than call a hasty muster-roll of names. Our country was then inhabited by great numbers of animals more or less related to our modern horse, tapir, wolf, panther, stag, musk, rhinoceros, camel, llama, etc. Besides these there were a large number whose modern representatives are not so well known—as the *Oreodon*, *Menodus*, *Uintatherium*, *Hyænodon*, and many others. This is but a meager list of the great number of Tertiary animals that have been discovered, but sufficient to show that a far richer and more wonderful assemblage of animals inhabited our land at that time than can now be found living on any continent; not even the jungles of India can produce such an array of gigantic pachyderms and carnivores as then lived in this country.

Again we are obliged to add, as with all the preceding ages, that both the luxuriant forests and these thousands of strange animals have become extinct, never again to appear on the earth. Dana remarks that "all the fishes, birds, reptiles, and mammals of the Tertiary are extinct species."

As we are writing sober facts and not attempting to trace an Arabian tale, we should hesitate to speak of the times that follow the Tertiary, so strange and wonderful are they, did we not have in the collection before us the unquestionable facts engraved upon tables of stone. As the climate of the Middle States in former ages extended to Greenland, so, on the other hand, there came a time, after all the fair picture of Tertiary days was blotted out, when the present climate of Greenland, with vast snow fields and continental glaciers, reached as far southward as New York and Cincinnati—a time when glaciers many thousands of feet in thickness moved southward over our Northern States, grinding down the country and exterminating nearly every form of life that before had found there a congenial home. This collection contains a large number of specimens of the bowlders, the bowlder-clay, and the polished and scratched surfaces, that the glaciers left behind them.

After the snow and ice of this great geological winter had passed away, and a climate very similar to that which we now enjoy had covered the land with its present flora and fauna, we find the first clearly acceptable evidence of the presence of man. The geological records before us are brought down to our own time by many relics of the stone-age of Europe and America, besides a collection illustrating the arts of the Egyptians and Etruscans. Here, too, is a cast of the celebrated fossil-man of Guadalupe, the original of which is in the British Museum.

One of the most interesting truths illustrated by the geological collections at the School of Mines, is the fact of the humble beginning of both plant and animal life on our globe, and their constant increase both in variety and specialization, as we follow their progress through the geological ages. Every one who is interested in the great question of our time—evolution—should make himself familiar with a collection of fossils arranged geologically, in order that he may see with his own eyes the facts written in the great stone book of the geologist, on which the man of science bases his theories and conclusions.—*American Naturalist.*

COLORING MATTER OF SANTAL AND CALLIATURA WOOD.

By N. Franchimont.

The coloring matter of these dyewoods is identical, and may be represented by the formula $C_{17}H_{16}O_6$. Calliatura wood is the richer in this compound. The pure color, on fusion with caustic potash, yielded acetic acid, resorcin, and probably proto-catechuic acid, and pyro-catechin.

DEPREZ'S ELECTRO-MAGNETIC ENGINE.

By the Count du Moncel.

According to Count du Moncel (writing in *La Lumière Electrique*) M. Marcel Deprez has succeeded in solving the problem of making an electro-magnetic motor capable of doing useful work in many industrial applications. We venture to doubt whether the new motor can compete with even a water motor as regards economy, to say nothing of gas and steam engines; but according to Du Moncel, Deprez's apparatus is barely 8 in. long by less than 6 in. in breadth; it weighs about 6½ lb., and can supply a power of nearly 8 foot pounds per second with five Bunsen elements. This (says Du Moncel) is really an extraordinary result, and one which could scarcely have been anticipated a few years ago. Under these conditions sewing machines may with perfect ease be worked by electricity without any cumbrous apparatus. This ingenious system consists of a horseshoe magnet of eight plates 5⅞ in. in length, between the poles of which is introduced a Siemens armature, acted upon by the magnet over a length of 2¾ in. Up to the present time no one has ever thought of causing magnets or electro-magnets to act otherwise than by their polar extremities; and all the engines devised hitherto have been arranged on this principle; but M. Marcel Deprez, thinking that under these conditions the whole of the magnetism that can produce a magnet was not utilized, endeavored to cause the whole of the sufficiently magnetized portions of the magnet engine to act upon the mobile system to be influenced; that is to say, in the present case, the branches of the magnet nearly up to the neutral line. The electro-magnetic armature, instead of being placed transversely to the magnet, is arranged longitudinally and parallel to it. Under these conditions the magnetic power exerted on the armature is found to be considerably augmented, as is perceptible from the difficulty experienced in producing rotation; and this increase of force may give an idea of the considerable advantages presented by this system of motor, which works by the effect of successive reversals of the current. Everybody knows the Siemens armature; it is a kind of galvanometer frame, of which two sides constitute the two poles of a straight electro-magnet with a flat core, broader than it is long, upon which the wire is wound. The axis of this electro-magnet is parallel to the coils of wire in the magnetizing helix, and, consequently, to the arms of the magnet. At one end it carries a reversing commutator, and at the other end it is provided with a pinion which gears into a wheel of which the diameter is 30 times greater. When the apparatus is properly regulated, the armature makes 90 revolutions per sound, and, consequently, the wheel which it acts upon makes three revolutions. It is upon the axis of this wheel that are fixed the pulleys transmitting the movement, and by which the engine is caused to work either a sewing machine or any other apparatus which is to be set in movement. In order to render the working of this apparatus perfectly uniform, M. Marcel Deprez has adapted to it an extremely ingenious regulator, the action of which is extremely efficacious. It is a sort of spring fixed by one of its extremities to one of the ends of the armature. By means of a screw, a tension suitable for any given velocity of the engine is given to the spring. The transmission of the current from the commutator to the wire of the armature is effected without difficulty by this spring, as in the case of all frictional contacts; but, when the velocity is greater than that which is requisite, centrifugal force is brought into action, and the mass of the spring causes it to fly off and to break the circuit, whence results a slackening of the speed, and then the completion of the circuit, which is again broken when the velocity again becomes too great. The alternations are so rapid when the electric power is somewhat higher than is strictly necessary, that a continuous spark is seen at the commutator where the regulating spring is in contact with it. Nothing can be simpler than this little apparatus, which, as at present constructed, may be of great service. Its force may be estimated by trying to stop the pulley, the diameter of which is nearly 4 in. With five Bunsen elements at work this stoppage can be effected only with great difficulty; whereas with the ordinary electro-magnetic engines it is easy to produce a stoppage by pressing a little upon the axis of rotation. Count du Moncel does not say what is the cost of five Bunsen elements, nor where they are to be placed when employed in working a sewing machine in a lady's boudoir.